COAL AGE

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DEVOTED TO THE OPERATING, TECHNICAL AND BUSINESS PROBLEMS OF THE COAL-MINING INDUSTRY

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Bell & Zoller

WHAT are the attributes of modern industrial leadership? While the catalog will vary in detail with each individual enterprise, certain characteristics will be both outstanding and common to all. Size, of course, is an ever popular yardstick, but sheer bulk alone is not determinative. Whatever the sum total of these attributes in a particular case, leadership, to be effective, must leave its imprint on the right side of the balance sheet.

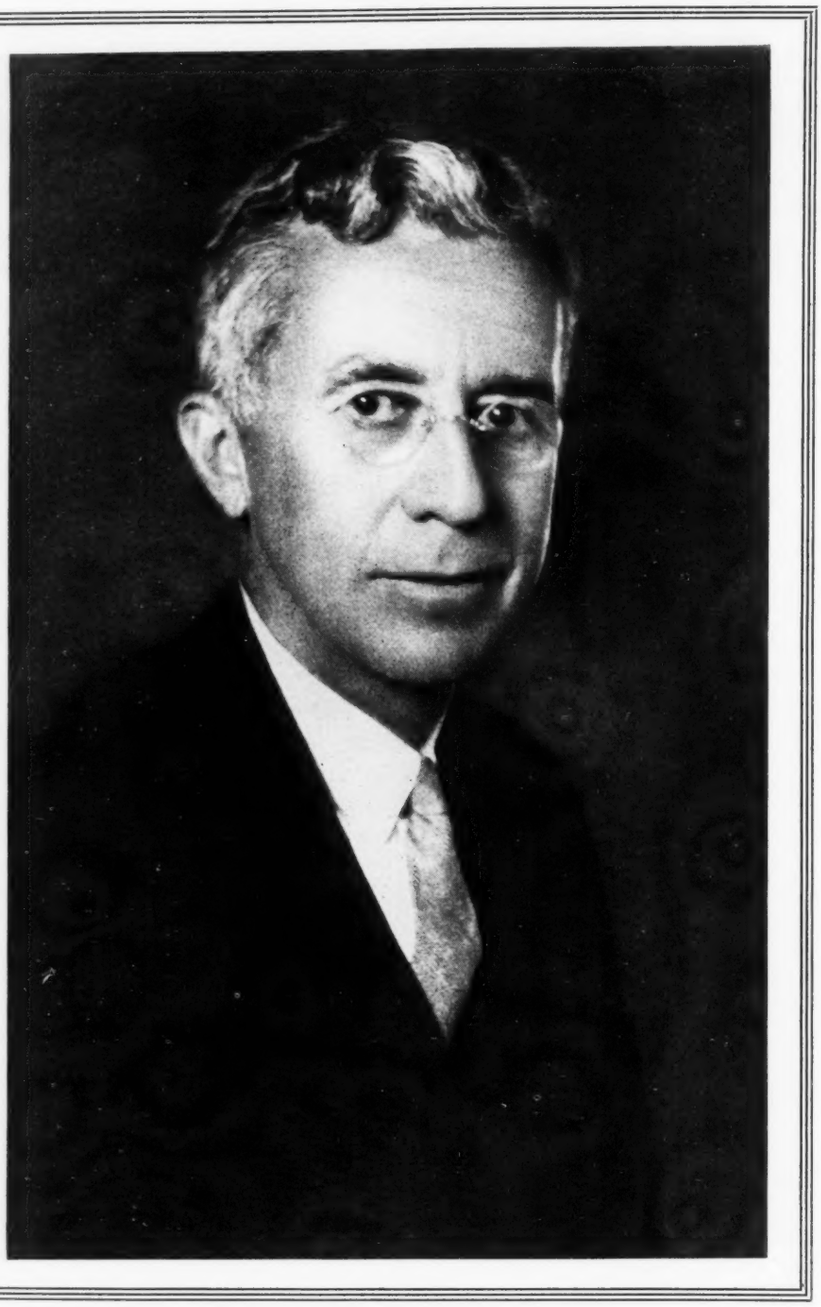
ONE QUALIFICATION, however, is cardinal. If leadership is to have the solidity and permanency without which continuing success is impossible, management must always be responsive to changing conditions and new ideas. It must be willing to test new methods and equipment and to expand their use as those tests demonstrate the soundness of the procedure adopted. Leadership in competitive industry must always be dynamic.

FIFTEEN YEARS ago, when mechanization in its present sense was largely conversational, Bell & Zoller made such a record in hoisting with hand loading that that achievement was featured in the 1922 Model Mining Number of *Coal Age*. Five years later, Bell & Zoller turned its Centralia mine into a proving ground for mechanical loading. Today its largest operations are completely mechanized and only one mine remains on a strictly hand-loading basis. The modern preparation plants of the '20s at Zeigler have been dismantled for a central washery.

THESE MAJOR CHANGES have been paralleled by comparable improvements in other phases of operation. Transportation practices and equipment have been in a continuous state of development. Safety has been recognized as the handmaid of efficient operation and the drive to lower accident rates is unremitting. Fresh experiments to further improve power-plant efficiency are now under way. Bell & Zoller management is fully conscious that to stand still is to move backward.

THE SPIRIT of accommodation to changing conditions is no less manifest in merchandising activities. A notable example of this is the Bell & Zoller domestic-stoker coal. Alert to the trend toward automatic home heating, the company turned its energies to preparing a coal which would satisfy the exacting demands of household consumers with stoker equipment. And increasing sales for the new product have been the reward for this enterprise.

BECAUSE the history of Bell & Zoller over the past decade presents such an illuminating picture of how progressive managements can make changing conditions opportunities for achievement, its story is the theme of *Coal Age's* Seventeenth Annual Model Mining Number. What has been done and how—shorn of the heartaches and disappointments which bestride the road to success—are told in the pages which follow.



HERBERT E. BELL

Chairman of the Board

Bell & Zoller Coal Co.

HOW IT ALL STARTED

+ Flashbacks in Bell & Zoller History

BACK IN THE '80s, a young man who had not yet reached voting age joined the wholesale coal firm of Richards, Pease & Co. in Chicago. The senior partner of the company was a member of a family long identified with Indiana coal production and distribution; F. N. Pease ended his career a few years ago as Chicago agent for the Erie anthracite interests. The young man, gray now but still active and a leader in the coal-mining industry of the Mid-West, was Herbert E. Bell.

What is now the Bell & Zoller organization, with five active mines captained by the famous Zeigler twins, had its roots in that induction more than a half-century ago. The Zoller name did not enter the picture, however, until several years later. In the meantime, the original firm of Richards, Pease & Co. was succeeded by Pease & Bell; this partnership, in turn, was dissolved in 1892 when Mr. Bell launched the Bell & Lea Co. Four years later Walter G. Zoller purchased the Lea interests and the Bell & Zoller Coal Co. was born.

A Pennsylvanian, Mr. Zoller got his first touch of coal when he became a telegraph operator at Braidwood, in the heart of the northern Illinois field—then one of the important producing districts of the State. He closed his telegraph key to journey to Chicago to become private secretary to a railroad superintendent, but was lured back to the mining region by the Wilmington Coal Operators' Association. He resigned from the operators' organization in 1896 to cast his lot with Mr. Bell. The business association thus begun between these two men continued unbroken until Mr. Zoller retired in 1927.

During the first ten years of its existence, the Bell & Zoller company was engaged primarily in wholesaling activities. For a time it was a sales agent for the Chicago-Carterville Coal Co., operating in Williamson County, and also handled some tonnage from the original Zeigler mine. Business was carefully nursed and growth was steady but moderate. The opportunity to step out in a big way in sales came shortly after the turn of the century, when James J. Hill, disgruntled at increased prices asked for dock coal, decided to look to Illinois for additional tonnage to meet the fuel requirements of the Great Northern and Northern Pacific railroads.

Without any foreknowledge of what was in the wind, Mr. Bell was invited to St. Paul, Minn., and ushered into the office of the Empire Builder. Mr. Hill, who had brought the first coal into St. Paul years before and had been one of the founders of the Northwestern Fuel Co., wanted to know how much coal could be purchased in Illinois; Mr. Bell replied that mine capacity was ample to take care of the railroad needs, but that it was questionable whether the carriers serving the mines could furnish the transportation facilities necessary to handle

On the square in Zeigler—Bell & Zoller operating headquarters

any additional tonnage. That, the coal man was assured, was a problem about which he need not worry. Mr. Bell left St. Paul commissioned to buy up all the surplus tonnage he could in southern Illinois—at Mr. Hill's price.

The first venture of the Bell & Zoller organization into direct mine operation was not made until 1906, when it took over the property of the Centralia Coal Co., opened the preceding year on the Marion-Washington County border. The next year the same interests launched the Central Washed Coal Co. at Pana. This plant, using Stewart jigs, had a capacity of 120 tons per hour and was the first installation in the State to wash down to pea size. Walter G. Zoller was president of the washery company and his brother, Robert H. Zoller, formerly general superintendent for the Chicago, Wilmington & Vermilion Coal Co., was general manager.

Committed now to producing as well as marketing coal, Bell & Zoller looked about for desirable additions to their Centralia operation. No section of the State was more in the coal eye than Franklin County, where twelve mines had been developed in six years. And no coal in the field had a higher reputation than that from the pioneer mine of the Zeigler Coal Co., owned by Joseph Leiter in 1904. But accidents and labor troubles had dulled Leiter's desire to devote his attentions to the coal industry. Removal of seals to extinguish a mine fire which started Nov. 4, 1908, had been followed by two explosions costing 29 lives in January and February of the following year and the mine had been ordered resealed by the State. It was still sealed in 1910, when the Bell & Zoller Coal Co. offered to lease the property if examination revealed that it was in an operable condition.

Table 1—Mines Operated by Bell & Zoller

Name	Location	Capacity*	Trade Name
Zeigler No. 1	Zeigler	7,000	Zeigler
Zeigler No. 2	Zeigler	6,000	Zeigler
Centralia No. 5	Centralia	2,000	Big Brilliant
Crescent No. 1	Peoria	2,500	La Marsh
Crescent No. 6	Peoria	3,500	La Marsh

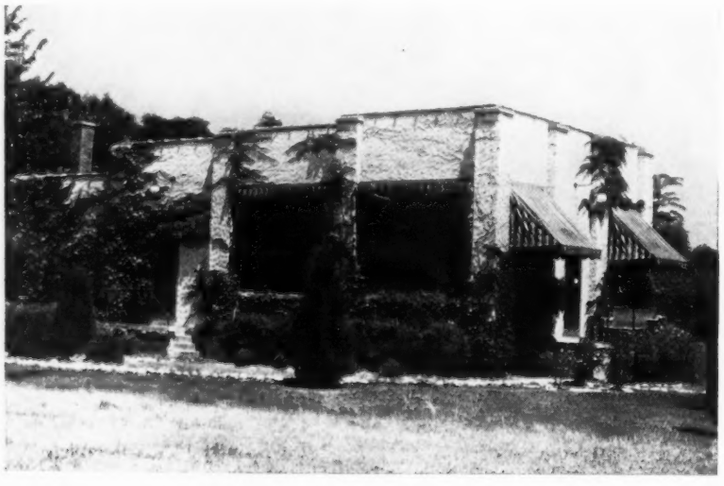
* Tons per 7-hour shift.

With Zeigler No. 1 again open and producing, the Bell & Zoller organization made no further move to expand its production facilities until it developed the Zeigler No. 2 mine in 1918. Both these mines, as well as Centralia, are now fully mechanized, and the coal from the Zeigler shafts is cleaned at the new central preparation plant erected in 1935. The most recent addition to the list of operations took place in 1930, when the Bell & Zoller interests purchased the properties of the Crescent Coal Co., in Peoria County. This acquisition included a drift operation started in 1920 and two mines—a drift and a slope—opened by Newsam Bros. Coal Co. in 1920 and 1922, respectively, and taken over by the Crescent company in 1924. One of the latter (No. 5—the drift mine) was abandoned when the Bell & Zoller interests purchased the Crescent properties.

Four separate corporations with common chief executive officers make up the present Bell & Zoller organization. The top organization is the original Bell & Zoller Coal Co., which also acts as sales agent for the three mine-operating companies. The Franklin County mines are operated by the Bell & Zoller Coal & Mining Co. The acreage of the two mines is still owned by the Zeigler Coal & Coke Co., controlled by the Leiter estate. In the case of the Centralia and Crescent mines the corporate entities of the operating companies have been preserved.

Changes in top personnel have been few since the organization of the Bell & Zoller Coal Co. in 1896. When Walter G. Zoller retired and sold his stock to his associates in 1927, Mr. Bell, who had been president, became chairman of the board of the allied companies. G. Donald Cowin, who joined the sales force in 1916, became sales manager in 1921 and vice-president in 1926, was elected president. Paul Weir, elected vice-president and general manager of the operating companies following the death of Robert Zoller in 1927, resigned to engage in private consulting practice last year and was succeeded by William P. Young, who had been transferred from Zeigler to Peoria in 1930.

H. F. McDonald is general sales manager and D. H. McMaster is director of sales promotion for the Bell & Zoller Coal Co. O. M. Gordon is treasurer and C. W. Peterson secretary of the sales and operating companies. All of these officials, except Mr. Young, who maintains his headquarters at Pekin, Ill., have their offices in the Bell Building, Chicago, as does F. E. McEvoy, purchasing agent for the four companies. J. M. Johnston, assistant general manager of the three operating companies, has his headquarters at Zeigler.



Crescent operating management heads up in this building at the No. 6 mine

MINING METHODS AND MECHANICAL LOADING

+ Bell & Zoller Mines

THREE fully and one partly mechanized mines are included in the Bell & Zoller group. Of the 100-per-cent operations, one, Centralia No. 5, operated by the Centralia Coal Co., was the second in Illinois to adopt the caterpillar-mounted loading machine, accompanying this step with one of the earliest mechanical-loading systems, as they are known today, in the Middle West. Centralia was followed within two years by the Zeigler No. 1 mine, Bell & Zoller Coal & Mining Co., in which operation a record of 1,295 tons in seven hours from one loading machine on a slab was hung up on April 19, 1937. Mechanization of loading at Zeigler No. 2 mine started in August, 1935, with the installation of the necessary loading and auxiliary equipment, and in the fall of 1936 work was started in 52-in. coal at the Crescent No. 1 mine, Crescent Mining Co., now 25 per cent mechanized.

Installation of loading machines at Centralia No. 5 mine began in the fall of 1927, and at present six Joy 5BU machines, exclusive of a spare machine, and four pit-car loaders are in service. Output of the 5BU machines ranges from 250 to 300 tons per shift of seven hours, and the output per man per shift, all underground men, averages between 10 and 11 tons. Individual machine records for a typical day are given in Table I.

Centralia No. 5 mine recovers the Illinois No. 6 seam under an average of 600 ft. of cover, although depth at the hoisting shaft is only 540 ft. Average coal thickness is 86 in.; working thickness, after leaving top coal in working places, is 80 in. Material overlying the seam varies widely, but generally is a gray slate up to 5 ft. in thickness, overlaid by limestone. Depending upon the immediately overlying strata, the roof varies from good to bad. In all cases, however, it is timbered systematically in working places with a minimum of two rows of props on each side of the track on 5-ft. centers, with 30 in. between the rails and the first row of props on each side. Also, props must be kept within at least 20 ft. of the face—closer if possible—and temporary posts are set so that after they are knocked out—after, of course, determining whether it is safe to do so—to permit the loader to work, the permanent posts will form a V at the face. As soon as one side of the place is loaded out, a safety post is set in the center and is not moved while the loader is in the place.

Table I—Number of Employees and Output on a Typical Day, Centralia No. 5 Mine

Employee Classification	Number
Hand loaders, days	2
Hand loaders, nights	2
Machine men	32
Mechanical mining, days	31
Mechanical mining, nights	12
Shift men, days	68
Shift men, nights	9
Company men, days	7
Company men, nights	1
Total	164
Top men, days	37
Top men, nights	4
Company men, days	11
Company men, nights	1
Total	53
Grand total	217

	Output, Tons
Joy No. 1	260
Joy No. 2	274
Joy No. 3	273
Joy No. 4	248
Joy No. 5	286
Joy No. 6	291
Joy No. 7	Spare
Conveyor No. 9	37
Conveyor No. 10	33
Conveyor No. 11	32
Conveyor No. 12	38
Conveyor No. 13	Spare
Hand loaders	84
Road coal	27
Total	1,883

Development at Centralia is based on the use of main, cross and panel entries, generally at right angles to each other. As at all other mines in the Bell & Zoller group, the "closed" room panel is employed; i.e., all rooms on a panel entry are surrounded by an unbroken pillar of coal, except where the pillar is pierced by the panel headings. Panel entries at Centralia consist of two headings 12 ft. wide on 52-ft. centers. Rooms 26 ft. wide on 60-ft. centers are turned both ways from the entry. Room depth varies from 400 to 450 ft., although 400 ft. is now the usual figure. In the past, also, as many as 40 rooms have been turned on a side of a panel entry. Now, the number has been reduced to twenty on a side, or 40 in a panel.

Panel entries normally are developed by the loading machines, as the pit-car loaders, each with a four-man crew doing all the necessary work, are reserved primarily for driving main and cross entries and similar tasks. In starting a panel, general practice is to drive the headings in far enough to turn eight or ten rooms on each side. Rooms are necked 12 ft. wide for a distance of 41 ft., measured from the center of the heading (Fig. 2). The neck is driven on a 45-deg. angle to facilitate haulage. Widening starts as soon as the direction is changed to 90 deg. with the heading. Necks are driven in about three cuts during the development stage, or enough to accommodate three cars. This insures a changing point every 60 ft. Consequently, changing or storage of empties and loads need be done on the cross entry only when the panel is breaking off. For convenience, tracks in the two headings comprising a panel entry are connected through 45s about every ten rooms.

After the panel entry is driven far

enough for eight or ten rooms to be turned, the original loader takes one side of the panel and the heading, while a second machine takes the opposite rooms and heading. Both machines then work the rooms on the advance until only eight or ten are left, whereupon one machine moves out, leaving the other to finish.

Loading-machine crews at Centralia No. 5 usually comprise 16 men, as shown in Table II. In addition, a man frequently is employed to clean up spillage along roadways, coal behind timbers, etc., and other coal which cannot be readily reached.

When a loading machine leaves a place at Centralia, it is followed by a skin-up, or clean-up, man, who shovels back loose coal, squares up the face and otherwise prepares it for cutting. The skin-up man may or may not be followed by the timbermen. At the start of the loading shift, barring reports of dangerous conditions, the timbermen prepare enough places ahead to permit the loader to work and then drop back and timber ahead of the cutting machine. Cutting is done with Goodman 112AA machines with 8½-ft. bars. Conversion of all cutters to Cincinnati "Duplex" chains and bits was started this year.

Shotholes are drilled with Chicago Pneumatic No. 472 post-mounted electric coal drills, using augers with "Humdinger" detachable bits. Rooms are shot with six holes normally placed about as shown in Fig. 1. Four holes are drilled in headings and other narrow places. Top holes are drilled as nearly straight in and as close to the top-coal parting as possible, with snubbing holes directly over the characteristic No. 6 "blue band," ½ to 6 in. in thickness and 8 to 12 in. above the bottom.

Drillers load the shotholes with Egyptian "Black Diamond No. 15" 1¾x6-in. permissible powder and tamp them. Top holes are loaded with two sticks; bottom holes with 1½ sticks. Finally, the drillers fire the three snubbing shots after the end of the first shift, using Ensign-Bickford safety fuse.

Table II—Standard Loading-Machine Crew, Centralia No. 5 Mine

Loader operators ($8.40)	1
Helpers ($7.65)	1
Machinemen ($8.40)	2
Drillers ($7.15)*	2
Snubbers ($7.15)†	2
Clean-up men ($7.10)	1
Motormen ($6.40)	1
Triprider ($6.00)	1
Swing-locomotive crew	1‡
Trackmen ($6.00)	2
Timbermen ($6.00)	2
Total	16§

* Also load dust and shoot snubbing holes.
† Also shoot top holes.
‡ Pro-rata share of two-man crew.
§ Does not include hand loader sometimes employed for cleaning up spillage and recovering coal behind timbers, etc.

Pulling out the coal broken down by the snubbing shots is the next step, carried out by two snubbers. In addition, the snubbers pick out and gob as much blue band as possible, thus decreasing the burden on the tipple. Pulling out the snubbed coal gives the top shots a better chance to roll the remainder of the cut out. At the same time, the hard blue band, which occurs at just the height the gathering arms attack the coal and otherwise would mean harder digging, is removed. Snubbers also fire the top holes to complete shooting in a place. The track then is extended and the place is ready to load when the timbers are advanced.

Each loading machine at Centralia is served by a single 5- or 6-ton Goodman Class 2600 cable-reel locomotive. Car changing is based on the "key-room" system shown diagrammatically in Fig. 2. Under this system, one room on each side is picked up from the key room about every 60 ft. by tracks through angle crosscuts. Consequently, maximum distance from face to a changing switch seldom is more than 60 ft. Trolley wire is hung in the key room to about the second crosscut. Holding changing distance to 60 ft. in the rooms on each side of the key room is accomplished by extending the track through the crosscut from the key room on across the side room and far enough into another crosscut to provide room for about three cars.

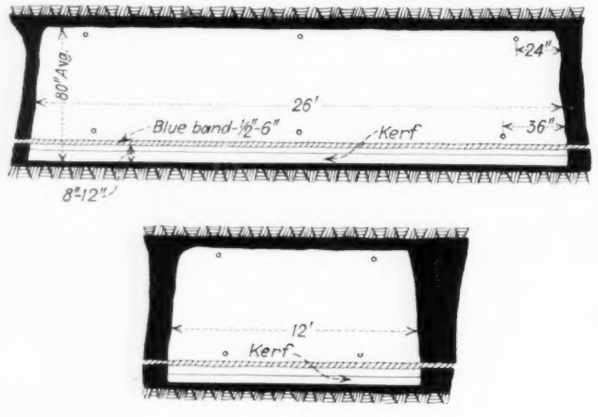
Serving locomotives usually bring three to five empty cars to the loading machine, kicking all but the last one in on the nearest crosscut track as fast as they are loaded. The last car is left at the machine while the locomotive takes the loads to the storage track, which may be the key-room track or a side-room branch. Empties then are picked up from the other available track, by which time the loader has filled the car left in place. Under this system, the locomotive never comes out on the heading except when moving from one key room to another. Relay, or swing, locomotives come into the rooms to leave empties and take out loads. Five swing machines (three General Electric 6-ton cable reel with 8-ton equipment and two straight 6-ton G.E. units) are employed. Main partings are installed about every 1,000 ft.

In addition to cutting changing distance, the key-room system, in conjunction with the relatively short crosscut distance, materially increases the number of places reachable without long moves. Besides the three room faces, never less than one and sometimes four crosscuts are available with a minimum of travel.

Initial mechanization at Zeigler No. 1 mine was based on 5BU loaders. Installation of higher-capacity units, aside from one 7BU unit in 1931, began in 1934, and now nineteen machines, of which two are spares, are in use. The list includes: eight 5BUs, one 7BU, seven 11BUs and one Goodman track-mounted loader. One of the 5BU units is worked two shifts, and two others constitute reserve machines. By classes of work, active machines are distributed as follows, rooms, seven 11BUs, one 7BU, three 5BUs and the Goodman loader; development, five 5BUs, of which one is double-shifted. Crews for room machines consist of twelve (5BU machines) or fourteen men, as shown in Table III. On development machines, the number in a 5BU crew may be increased to fourteen, depending upon switchlaying and other services required.

Supplementing men directly engaged in mining, loading and hauling coal, one electrician is on duty for each group of four or five machines. Where possible, a relay motorman

Fig. 1—Drilling plans, rooms and headings, Centralia No. 5 mine



and triprider also are provided for every two machines. A section boss, or assistant mine manager, oversees three to five machines and has under his jurisdiction five two-man crews of switchlayers, five two-man crews of timbermen and one or two trappers for use as needed. When these extra men work inside a room their time is allotted to the loader foreman; if on a panel or other entry, their time is carried by the section foreman.

The 5BU loaders at Zeigler No. 1 now average 300 tons per shift of seven hours, as compared with 225 to 250 tons in eight hours shortly after mechanical loading started in 1929. The difference represents increased concentration of working areas, improved track construction and larger and better mine cars with better control of transportation (p. 88), improved supervision, better men more thoroughly grounded in the operation of mechanization equipment, and mature experience in loader operation.

Experience at Zeigler No. 2 mine epitomizes developments in converting a hand-loading mine to a mechanical operation, with the added complication of utilizing the existing labor force. No. 2 now employs sixteen loading machines, with one spare (a 5BU) in addition. Working machines are: six 5BUs and ten 11BUs.

Standard crew make-up at No. 2, as indicated in Table III, differs in only one important respect from that at No. 1. This difference at No. 2 is the use of two serving locomotives, meaning two motormen, on 5BU machines. At No. 1, however, the 5BU machines are almost entirely confined to development. When this article was prepared, average 11BU output at No. 2 was 430 to 450 tons per shift of seven hours, with 5BUs averaging 220 to 230 tons.

In installing machines at No. 2 it was decided to utilize the existing labor force, dividing the employees into two groups and starting off by splitting available working time equally between the groups on the basis of five days on and five days off. This naturally involved converting, for example, hand loaders into loading-machine operators, etc., in the course of which every attempt was made to assign men to jobs for which they expressed a preference or, in the absence of preference, to jobs to which it appeared they might be best suited, supplementing this with changes when warranted by experience. With this foundation established, operation began in August, 1935, on the basis of learning while working.

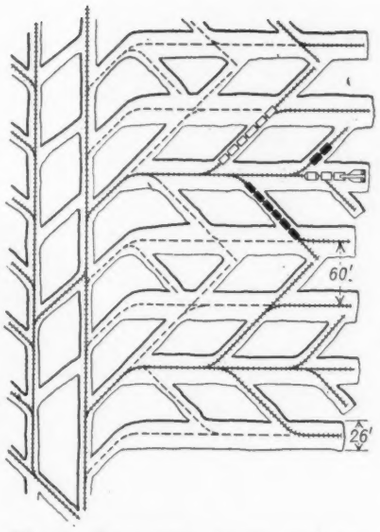


Fig. 2—Room-track layout and car-changing system, Centralia No. 5

Learning while working also applied to the supervisory force, although the handicap was reduced somewhat by drawing on experience at No. 1 mine. All No. 2 bosses spent a week or two weeks at No. 1 mine; next, classes were held for a period of several weeks at which the various elements entering into mechanization of loading and the conduct of auxiliary activities were discussed. As a result, No. 1 bosses benefited by a thorough airing of mechanization problems and principles and No. 2 bosses got a good grounding in how to operate a mechanicized mine. In addition, the meetings presented the best possible opportunity for establishing standards governing efficient performance of the various duties involved in loading coal with machines, and also for clearing up misunderstandings as to objectives.

Table III—Standard Loading-Machine Crews, Zeigler Nos. 1 and 2 Mines*

	11BU, 7BU Goodman	5BU
Loader operators ($8.40)	1	1
Helpers ($7.65)	1	1
Skin-up men ($7.10)	1	1
Timberman ($6.00)	1	1
Machinemen ($8.40)	2	2
Drillers ($7.15)	2	2
Shooters ($7.15)	1	1
Motormen ($6.40)	2	2†
Tripriders ($6.00)	1	1
Tracklayers ($6.00)	1	1
Tracklayers' helpers ($5.75)	1	..
Total	14	13†

* Excludes electricians, relay locomotive crews, tracklayers, timbermen and trappers chargeable at times to loader sections, as explained in accompanying article.

† Only one motorman employed at Zeigler No. 1, making crew total 12; on development machines at No. 1, crew total may be increased to 14, depending on extra switchlaying and other work required.

Among the problems accompanying the installation of loading machines at No. 2 was concentration, growing out of a reduction of 50 per cent in number of working places required. The goal is all loading machines to three partings, which means working out all the extra territory needed for hand loading and also finishing operations in room panels where coal actually was being loaded by hand.

Divided working time also involved another handicap, principally in slacking off by one group at the end of a five-day period and the other group at the beginning of the next. In the latter case, this was the result primarily of lack of familiarity with conditions after the changes in the preceding period. From the standpoint of other problems, progress at No. 2 is closely paralleling that outlined above for No. 1. Installation of larger mine cars, in particular, is expected to raise output substantially from the figure of 5,400 to 5,900 tons prevailing last summer, with the possible upper limit as 7,000 tons in seven hours with the same number of dumps and machines.

Both Zeigler No. 1 and No. 2 mines operate in the Illinois No. 6 seam, 8 to 12 ft. in thickness, of which about 7½ to 8 ft. is mined. The immediate roof is a shale or slate, in many cases needing protection of top coal. Depth of cover is about 400 ft. at No. 1 mine and 300 ft. at No. 2. Underlying the seam is a fireclay.

Main, cross and panel entries are employed in opening up territory at the Zeigler mines. Thirty-two rooms, sixteen on each side of the entry, make up the usual room panel, which is surrounded on three sides by pillars approximately 30 ft. thick. On the fourth side, the pillar approximately 80 ft. thick between the first rooms and the two "aircourse rooms" (Fig. 3) is pierced by two headings 12 ft. wide on 34-ft. centers. The first of the "aircourse rooms" usually is driven about 80 ft., center-to-center distance, away from the cross-entry heading. The two rooms are connected from one room panel to the next and thus form a continuous aircourse paralleling the cross entry.

Rooms are driven 26 ft. wide on 50-ft. centers. Depth varies somewhat with conditions, but averages approximately 350 ft. In starting a panel at No. 1 mine, the first two rooms are driven in about 150 ft. to provide storage for empty and loaded cars during subsequent operations. The development machine then

Shortwall machines undercut the coal at Zeigler mines

Holes are put in with post-mounted electric coal drills

Loading holes with carbon-dioxide cartridges at Zeigler

Compressor of one of the air-shooting units employed in development work at Zeigler

Cut shot down in room ready for the loading machine, Zeigler mines

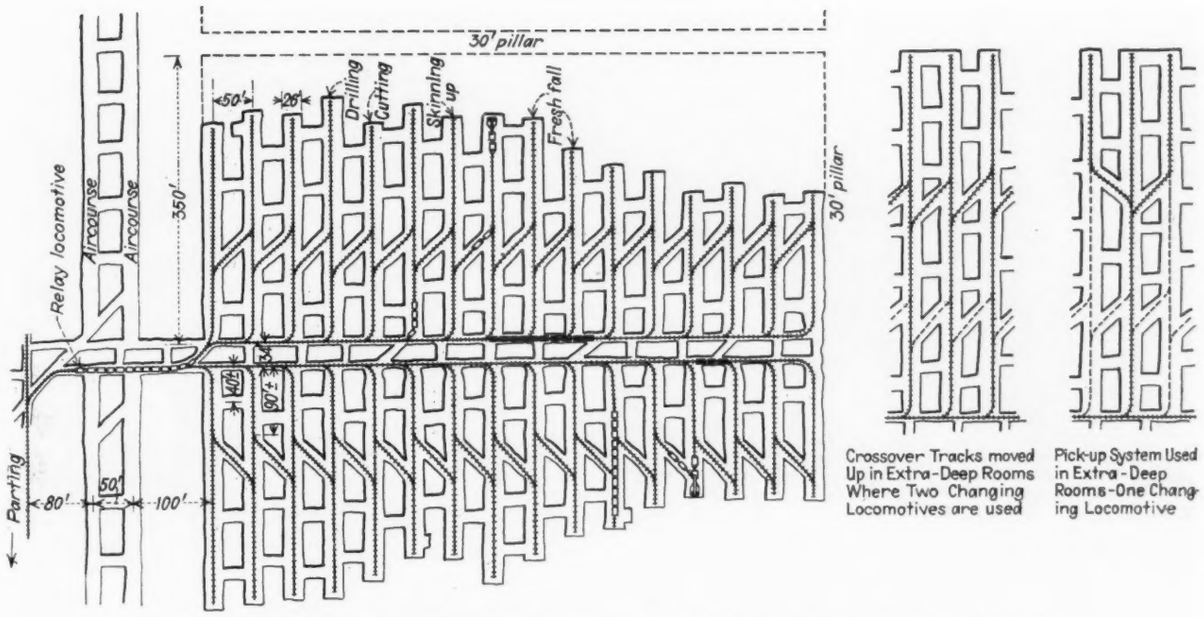


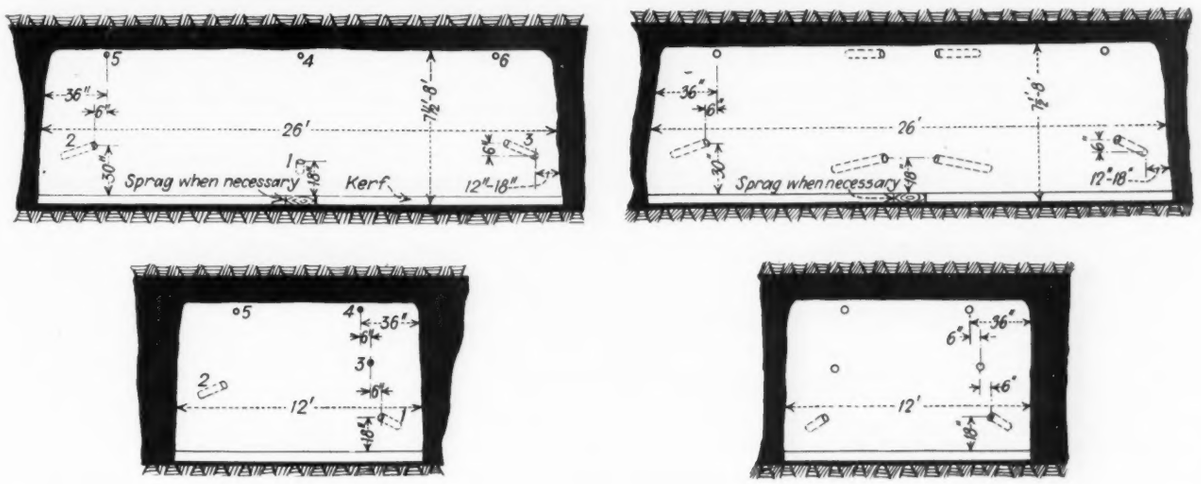
Fig. 3—General plan of room panel at Zeigler Nos. 1 and 2 mines, showing, left, track layout and car-changing methods. Second from the right is a diagrammatic sketch showing how the changing track is moved up in rooms more than 350 ft. deep where the loading machine is served by two locomotives. If only one locomotive is used, two rooms are picked up from a "key room" when the changing switch is moved up, as shown at the right

works ahead until it has opened up eight or ten places on each side, whereupon it is taken out and a regular production machine substituted. The latter continues to drive the headings and starts the normal room-working schedule. As soon as possible the 7th and 8th (or 8th and 9th) rooms on each side are driven in about 150 ft. to serve as storage points for subsequent heading driving and room necking. Number of machines in a panel is limited to one until the rooms are driven in far enough to provide changing room—usually about the first crossover (Fig. 3). Two loaders, one on each side, always are operated in each panel after enough changing room is available so that there will be no interference between the two.

At No. 2 mine, a 5BU machine usually is employed to drive up the panel entry and neck the rooms, after which a 11BU unit moves in and starts regular operation in the rooms. Then, as soon as the rooms are in to the first crossover and sufficient changing room is available, a second 11BU machine is introduced.

All coal at Zeigler Nos. 1 and 2 mines is broken down with Cardox or air. As the former cannot be released during the working shift, one Airdox machine has been installed at each mine for breaking down coal during the day, primarily in development sections. Three-inch-diameter low-pressure Cardox shells are employed, and with this low-pressure medium, in which the charge per hole cannot be varied at the face, face-preparation methods are closely controlled to remove all possible resistance and insure that each step in the cycle is properly

Fig. 4 (left)—Standard hole-placement plan for carbon-dioxide shooting of rooms, and the most used plan for headings, Zeigler mines. Fig. 5 (right)—Drilling plans for air shooting, Zeigler mines.



Loading machine at work in one of the Zeigler operations

performed. This eliminates hardship on men performing the succeeding step or steps in the cycle and also reduces the possibility of a badly shot cut.

As the charge per hole is the same in all cases, hole placement also must be regulated carefully so that the burden is not excessive on one hole and at the same time is as nearly equal as possible on all. This is in contrast to first drilling the hole and then adjusting the charge, as is frequently done with other mediums. In addition, as much coarse coal must be secured as possible without lumps too big for easy loading or for handling through dumping and preparation equipment.

Face preparation starts with the skin-up man (Table III), who is expected to throw back loose coal and clean up and square up the face. Cutting is the next operation, using Jeffrey 35B and BB shortwalls with 8½-ft. cutter bars making kerfs averaging 7½ ft. in depth. Hard-surfaced bits (see article beginning on p. 125) are used, giving somewhat coarser cuttings as a result of the bits staying sharper longer.

Places are driven with sight lines, and emphasis is laid on cutting straight ribs and square faces, and also on leaving a uniform bottom of about 4 in. These steps insure ideal shooting conditions by reducing the resistance to the breaking force of the Cardox or Airdox charges. Cutter helpers are expected to shovel away as much dust as possible while the machine is cutting so that the dust will not be carried back and packed under the cut. Helpers also dedust the undercut to the extent their work will permit. Cutters may be followed by the tracklayers, who extend the track to within about 10 ft. of the face, although the trackmen may do their work at some other convenient time. Two short rails with splice bars on one end are carried on the loading machine for making temporary extensions while coal is loaded.

Drilling at Zeigler mines receives careful supervision, with particular attention to the placement and firing of snubbing shots to turn over and roll out the lower part of the cut. Snubbing shots which merely set the coal down and lock it in place, with the result that the top coal falls onto the snubbed coal and fails to roll out, locking the snubbed fraction still more firmly, are regarded as almost a minor calamity in that the extra digging by the loading machine decreases the output and increases maintenance. Where the coal after being cut is inclined to sag or fall, regulations require spragging it under the center snubbing hole so that the snubbing charges will have the proper resistance to work against and thus can roll out the lower part.

Drilling crews are allowed some latitude, but in general are guided by standard hole-placement plans and instructions. And in addition to the actual drilling, crews also have the duty of completing bugdusting of the cut and of placing and wiring the Cardox shells. Six holes located approximately as in Fig. 4 are used in shooting a 26-ft. room. The three top holes are drilled on the same level about 2 in. below the natural parting line under the top coal. Rib holes are drilled parallel to the center line of the place.

The center snubbing hole in a room is started about 18 in. above the top of the kerf. Rib snubbers are drilled high enough so that the top rib holes will not be overloaded, which usually means about 30 in. above the undercut. Rib snubbers also are started 6 in. closer to the side than the top rib holes, and are angled outwardly from 12 to 18 in. These two measures insure that the bottom will be broken down under the top rib holes and also that the back corners will be cleaned out to the rib lines. Snub holes are pitched about 6 in. downward for maximum rolling-out effect. All holes, 3½ in. in diameter and drilled with Chicago Pneumatic post-mounted equipment, are 12 in. shorter than the undercut. Headings are shot with five holes as a rule. Although alternatives are employed at times, the most general hole-placement scheme is shown in Fig. 4, using holes zigzagged to the top row. As they are fired from the bottom to the top, the lower holes relieve the next above in order.

Loading of holes and attachment of firing wires to the shells are the final operations on the working shift. Shells are fired by shooters on the following shift who ignite one shell at a time, recover and pile used shells and remove the wires, and replace bad-order and hot shells with new ones when necessary. Shooters are prohibited from using extra shells in tight or overburdened holes, and must go around two corners before firing. Each shell is filled with 6½ lb. of carbon dioxide, and shooting practice is aimed at not less than an average of 7½ tons of coal per shell fired. Shells are trucked from the Cardox plant at Benton, Ill.

Two Extra Holes With Air

Since the productive capacity per unit of volume of compressed air is somewhat less than that of Cardox, in Airdox shooting two extra holes are used in a 26-ft. place and one extra hole in 12-ft. headings (Fig. 5). Hole diameter is 4 in. Hole levels in rooms are approximately the same as with Cardox shooting, but the center holes in the top and bottom rows, all four drilled from the same set-up, are angled outward so that the distance between all holes is approximately the same in the back. Airdox units normally work two shifts per day, and may serve as high as three loading machines. At No. 2 mine, for example, one Airdox machine was shooting two shifts for three loading units, and has shot as high as 172 holes in seven hours. The general average at both Zeigler mines, however, is 120 holes per shift.

Two rows of posts on approximately 5-ft. centers are the minimum requirements in rooms. Minimum clearance outside the rails is 30 in., and posts must be kept within at least 20 ft. of the face. The last posts next to the face are set to form a V in which the loading machine works. Timbermen may work along with the loader or at other convenient times.

Except in the case of the development machines at No. 1 mine, each usually serviced by but a single locomotive, the general practice is to use two locomotives for changing cars behind loading machines, subject to exceptions where conditions warrant. Cable-reel equipment at No. 1 consists of 8- and 6-ton General Electric, Goodman, Jeffrey and Westinghouse locomotives, supplemented by five Mancha storage-battery units with Philco batteries. The 8-ton equipment is reserved as far as possible for relay service. Gathering and relay tasks at No. 2 are handled by 8- and 6-ton Jeffrey cable-reel locomotives.

Table IV—Employees Underground and Output on a Typical Day, Zeigler Nos. 1 and 2 Mines

	Zeigler Mine No. 1	Zeigler Mine No. 2
Loading machine operators	19	17
Loading machine helpers	19	15
Skin-up men	18	15
Cutting machine operators	20	17
Cutting machine helpers	20	15
Drillers	40	32
Inside motorman	39	38
Main-line motormen	6	7
Inside tripriders	28	23
Main-line tripriders	6	7
Timbermen on Joys	21	15
Timbermen inside	9	18
Timbermen main line	4	6
Tracklayers on Joys	33	15
Switchlayers inside	4	15
Switchlayers main line	2	3
Tracklayer's helpers on Joys	25	9
Switchlayers helpers inside	9	15
Switchlayers helpers main line	2	3
Trappers	11	5
Seal builders	2	6
Bratticemen	3	3
General bottom	11	14
Pipemen	1	1
Electrical dept., days	30	26
Electrical dept., nights	15	19
Examiners day	1	2
Examiners night	5	6
General night men	25	25
Mechanical rock loading	..	3
Miscellaneous	—	6
Shooters, Cardox	15	13
Airdox coal breakers, days	2	2
Airdox coal breakers, nights	2	2
	447	417
Company men, days	24	23
Company men, nights	2	2
	473	442
Daily output, tons	7,000*	5,600†

* Approximate average. † At time article was prepared.

To shorten the changing distance and facilitate two-locomotive service, switches are laid when rooms are about 90 ft. in from the heading. From these switches, tracks in adjacent rooms are connected through angle crosscuts, as shown in Fig. 3, making a changing point a little less than half way up each room. This changing point serves until the room is worked out, unless the depth goes much beyond 350 ft., in which case, where two locomotives are used, the changing point is advanced about 100 ft. (Fig. 3). Where single locomotives are employed at No. 1, a room on each side of a key room is picked up at the second changing point.

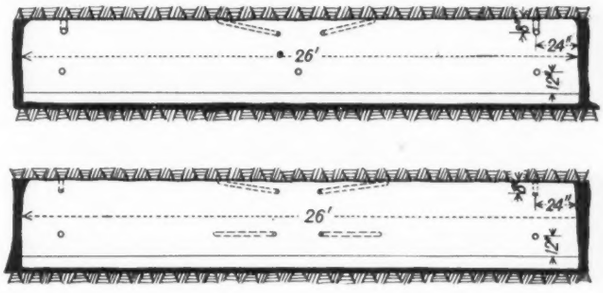
Adoption of the principle of two service locomotives for machines in regular production took place in 1932 as a means of increasing loader working time. As another means to the same end, old mine cars have been and are being replaced with larger types (see article beginning on p. 88). Relay hauls, where possible, are kept within 2,000 ft. Relay locomotives usually handle 8- to 12- car trips, heading them into the second place below where the loader is working. The relay motor then proceeds on up the heading and hooks onto the loaded trip made up by the service locomotives. Of the two latter units, one uses the straight track in the room and the other the crosscut track at all times, so that it never is necessary in coming out of the place to stop to throw the changing switch. While one car is being loaded, the other locomotive hooks its load to the relay trip, picks up an empty and runs back to the changing switch, where it waits until the other locomotive comes out and then heads in without back-switching.

Mechanization of the Crescent mines of the Crescent Mining Co., operating in Illinois No. 5 coal averaging 52 in. in thickness on La-Marsh Creek, near Peoria, Ill., started in 1936. To date, the output of Crescent No. 1 mine, averaging 2,225 tons per day, is approximately 25 per cent mechanized with three loading machines, one operated two shifts. Crescent No. 6 mine, averaging 3,430 tons per day, still is on the hand-loading basis.

The seam at Crescent rests on a soft fireclay bottom, which slacks in air and disintegrates when wet. Over the seam is 1 to 5 ft. of gray slate and 2 to 7 ft. of clod, followed by sandstone. Cover thickness varies from nothing at the outcrop to 160 ft.

Crescent mines also employ main, cross and panel entries, generally

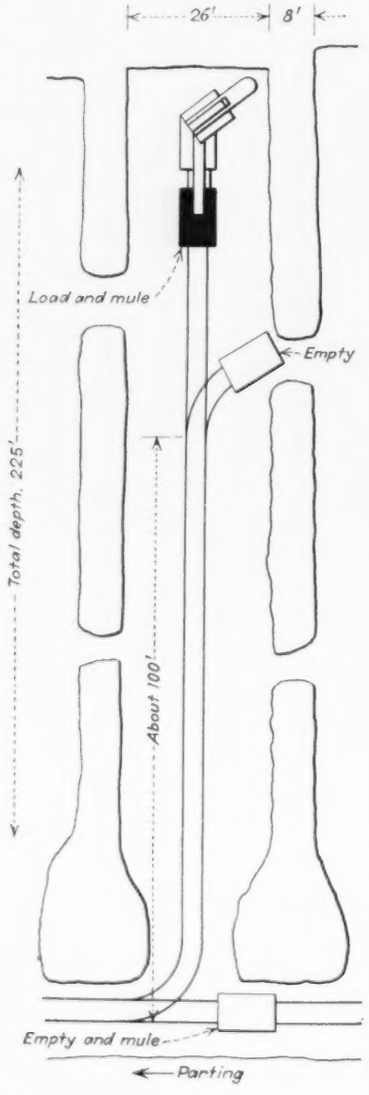
Fig. 6—Usual hole placement in rooms in mechanical-loading sections, Crescent No. 1 mine. Four holes are used in headings



made up of two headings as follows: mains and crosses, 8 ft. wide on 30-ft. centers; panels, 12 ft. wide on 40-ft. centers. The extra width of panel headings permits disposing of material derived from bottom lifting and other sources on the rib opposite the room necks. On all other entries, all refuse and bottom material is loaded out.

As at other Bell & Zoller-group mines, the "closed" panel system is employed, with rooms 26 ft. wide on 32-ft. centers turned off both sides of the entry. Usual depth is 225 ft. Normally, a panel is made up of twenty rooms on each side, or 40 in all. However, to accommodate the panel parting, what normally would be the first room on each side (see plan and discussion in article beginning on p. 88) is started 300 ft. in from the cross entry and is

Fig. 7—Car-changing plan for mules, Crescent No. 1 mine



driven only 12 ft. wide. From these "stubs," stub rooms 225 ft. deep and parallel with the panel entry are driven back toward the cross entry. In other words, the first room on each side of the panel entry becomes an auxiliary haulage heading for working out the stub rooms. Limiting the number of rooms to 20 on a side and locating the parting in the mouth of the panel entry are done to reduce the tramming distance for the mules used in gathering haulage.

All coal at Crescent is undercut with shortwall or breast machines, as follows: No. 1—eight Jeffrey 35A, three 35B, one 27B breast, two Goodman 112A universal, one 112AA and three Goodman 119 breast; No. 6—twelve 35A, one 27B breast, six 112A and nine 119 breast. Cutter-bar length on machines in hand-loading sections is 6½ ft. Experiments with Borod-tipped bits have been under way for about 1½ years. Drilling in hand-loading sections is done by the miners with post-mounted hand augers, and the coal is shot with duPont, Western or Equitable 1¾-in.-diameter pellet powder and Ensign-Bickford safety fuse.

Crescent Uses Three Loaders

Mechanical loaders at Crescent No. 1 mine include one Jeffrey 44DD, one 44EE and one Joy 8BU, the latter double shifted. The standard crew on the 8BU type is fourteen men, with duties as in Table V. Jeffrey crews have one extra trackman. In addition, a switchlayer and a timberman for work back from the face are employed as necessary. After loading is completed in a place, a skin-up man cleans up and squares up the face and takes up and gobs the bottom left by the cutting machine. The place then is undercut about 6 ft. 8 in. deep.

Drilling follows cutting, using Chicago Pneumatic electric drills. Jeffrey places are shot with seven holes placed as in Fig. 6. Eight holes are used in the Joy section. As the coal is "burned" tightly to the roof, all top holes are angled up to the slate to break the coal loose. Drillers also load and tamp the holes, which are fired after the working shift. Fuse lighting and fuse length are adjusted so that the middle holes in the bottom go first, followed by the bottom rib holes, the middle holes in the top and, finally, the top rib holes. At the start of the next shift, the bottom is taken up by a grader to permit extending the track. Only enough bottom is lifted to sink the rails, placed on steel ties in

Table V—Standard Loading-Machine Crews, Crescent No. 1 Mine

	Jeffrey 44DD, 44EE	Joy 8BU
Loaders operators ($8.40)	1	1
Helpers ($7.65)	1	1
Cutters ($8.40)	2	2
Drillers, shot loaders ($7.15)	2	2
Graders ($5.75)	1	1
Trackmen ($6.00)	2	1
Timbermen ($6.00)	1	1
Drivers ($6.00)	2	2
Car pushers and trimmers ($7.10)	1	1
Skin-up men ($7.10)	1	1
Foremen	1	1
Total	15*	14*

* In addition, switchlayer and timberman as needed.

mechanical-loading sections, to a point where the tops are just level with the floor. Timbers are set and extended as the coal is loaded.

Car-changing behind loading machines is done with two mules at Crescent No. 1. To facilitate changing, a switch and spur track just long enough to accommodate a car are laid when the room is driven half way up (Fig. 7). When a car is loaded, one mule starts with it to the parting, never more than 900 to 1,000 ft. away in room panels of the usual size. When the mule passes the switch in the room, the car pusher, or trimmer, pulls the empty car out of the spur and pushes it to the loading machine. The pusher also moves the car and trims it during loading.

While the car is being loaded, the first mule proceeds to the parting, passing the second, with an empty, at the mouth of the room. This second mule then switches its car into the room, leaves it on the spur and proceeds to the loading machine. Under this system, car-changing time is approximately one minute, while the time required for loading is about two minutes. Usually, the latter is just sufficient for a mule to make a round trip to the parting.

On the 44DD machine, for example, a time study covering June 8, 9 and 10, 1937, showed changing times of 1.08, 1.04 and 1.01 minutes; loading times of 1.98, 2.00 and 1.90 minutes; and moving times of 10.30, 9.45 and 9.55 minutes. Shift times were split up as follows: June 8—changing, 110 minutes; loading, 202; moving, 103; delays, 5; June 9—changing, 97; loading, 182; moving, 103; delays, 36; June 10—changing, 103; loading, 193; moving, 86; and delays, 29 minutes. Cars (approximately 2.4 tons each) totaled 102 on June 8, 93 on June 9 and 102 on June 10. In the first seven months of 1937 (91 shifts) day-shift machine averages were: Joy 8BU, 200 tons; 44DD, 205 tons; 44EE, 195 tons.

G. DONALD COWIN

President

Bell & Zoller Coal Co.

TRANSPORTATION

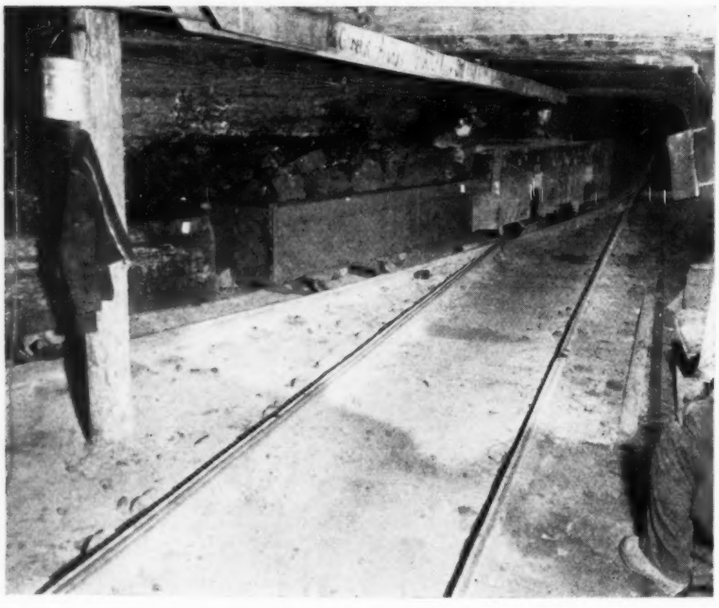
+ Bell & Zoller Mines

TRANSPORTATION at mines in the Bell & Zoller group has been marked in the last few years by additions to and improvements in rolling stock, reconstruction of roadbeds and the adoption of improved control methods to maintain and increase efficiency in the face of constantly increasing haulage distances. In only two instances is the main-line haul less than two miles, with a minimum of 1¾ miles, while the maximum runs up to three miles at the Crescent mines, near Peoria, Ill. A further factor which has had a material influence on haulage methods and equipment is mechanization of loading, which still continues at the Crescent operations.

With the exception of the Crescent mines, all Bell & Zoller operations are served by hoisting shafts. Hoisting distance at Zeigler No. 1, equipped with 10-ton skips, is 460 ft.; No. 2, 345 ft.; Centralia No. 5, 600 ft. Steam hoists are used in all cases. Sizes are: Zeigler No. 1, 6- to 9-ft. stepped drum, 28x42-in. engine; No. 2, 10-ft. cylindrical drum, 28x42-in. engine; Centralia No. 5, 10-ft. cylindrical drum, 24x42-in. engine. A rotary car lumper and Link-Belt automatic skip-loading equipment serve the skips at Zeigler No. 1, where the record has been 2,003 cars in seven hours, or 7,486 tons. Zeigler No. 2, equipped with self-dumping cages, has a top capacity of 1,600 dumps in seven hours, expected, when all the new cars contemplated are installed, to give a maximum output of 7,000 tons in seven hours. Self-dumping cages also are used at Centralia No. 5, where the record to date is 1,107 dumps (slightly over 2½ tons per car) in eight hours. Nolan cagers are used at both Zeigler No. 2 and Centralia.

Two light-pitch slopes (empty, 3 per cent; loaded, 1½ to 2 per cent) serve Crescent No. 1 mine. Loads are fed from a storage track on the surface to a Link-Belt car haul (both empty and loaded chains) which takes them to a rotary dump in the top of the tipple. At Crescent No. 6, the original hoisting shaft was replaced by an 8x8-ft. belt slope in 1932, supplemented by a 5x8-ft. man-and-material slope on a 22-deg. pitch. Inability of the shaft to accommodate the new and larger cars which went into service at that time, along with higher labor and power costs as compared with a slope, were the major reasons for the change in facilities.

Main lines are laid with 60-lb. steel on treated ties at Bell & Zoller mines. This view shows a 13-ton haulage locomotive on its way to the outside at Crescent No. 6



Slope Fitted With 48-In. Belt

Pitch of the new belt slope is 18 deg. 1 min. A Link-Belt installation, the slope is fitted with a 48-in.-wide belt 440 ft. long between pulley centers. At the bottom of the slope, a one-car rotary dump is set above a weigh basket. The chute to the latter is provided with a gate for dumping rock and refuse into a separate bin, while the coal goes on through the weigh basket onto a pan feeder and then onto an apron feeder conveyor discharging onto the belt. The weigh-basket gate is arranged so that selected cars can be dumped onto an auxiliary apron conveyor for inspection and docking, if necessary. The auxiliary apron conveyor discharges onto the main apron unit, and the auxiliary also receives rock from the rock bin for eventual discharge onto the belt. When hoisting rock, the apron feeder conveyor is run free of coal and a space on the belt is cleared, whereupon the auxiliary apron conveyor is started. As soon as the rock ap-

pears at the discharge end of the belt in the tipple, a gate is opened to divert it to an aerial-tramway-feed bin.

Rated capacity of the Crescent No. 6 slope installation is 500 tons per hour. It has handled 3,500 tons of coal and 350 tons of rock in one shift of seven hours. The conveyor is driven by a 125-hp. General Electric motor, and the original belt (Goodyear) shows little signs of wear after handling over 5,000,000 tons of material.

With the exception of the Crescent mines, single-track main lines are the rule at Bell & Zoller operations. Passing tracks are provided at Zeigler No. 2 and Centralia No. 5 in certain cases, while at Zeigler No. 1 the mine layout is such that passing tracks are not required. Where locomotives at No. 1 must use a common track in one or both directions, interference is prevented by means of Mines Equipment Co. manually operated block signals. Electric switchthrowers furnished by the same company are installed at the principal junction and switching points in the mine. Much the same general practice is followed at Zeigler No. 2 mine, except that two of the main-line routes are equipped with two passing tracks each, with proper block-signal equipment. Dispatchers are employed at both mines, although they might more properly be called car distributors, as their major task is to keep a record of cars handled and direct them to the proper places at the time they are needed. Actual movement of the trips, however, is controlled by block signals.

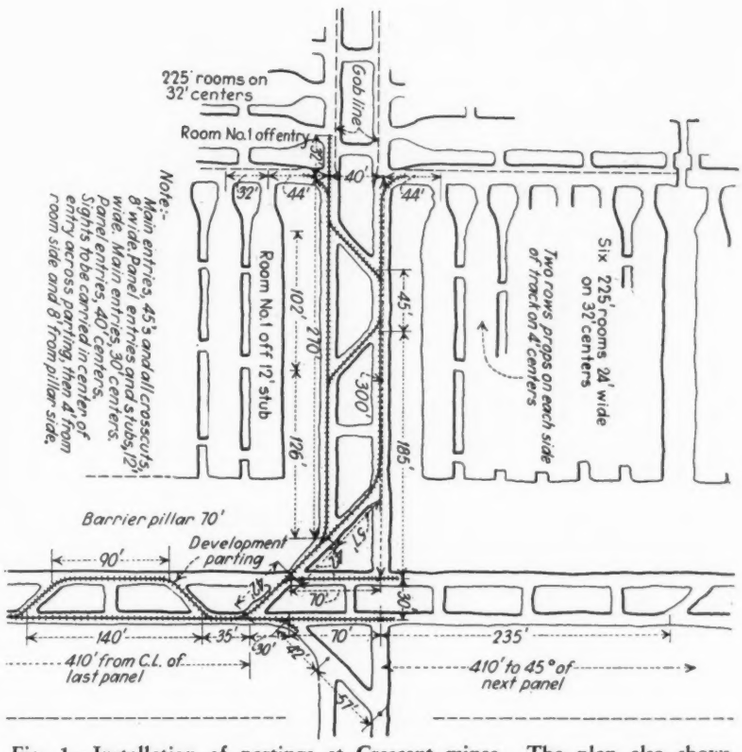

225' rooms on 32' centers
Gob line
Room No.1 off entry
Note:- Main entries, 45's and all crosscuts, 8' wide. Panel entries and stubs, 12' wide. Main entries, 30' centers. Panel entries, 40' centers. Sights to be carried in center of entry across parting, then 4' from room side and 8' from pillar side.
Room No.1 off 12' stub
Six 225' rooms 24' wide on 32' centers
Two rows props on each side of track on 4' centers
Barrier pillar 70'
Development parting
410' from C.L. of last panel
410' to 45° of next panel

Fig. 1—Installation of partings at Crescent mines. The plan also shows method of turning rooms off the stubs on each side of the panel entry

Loads Traded for Empties

At Centralia No. 5 mine, one man is employed to count loaded cars in a trip and advise the bottom, which gives the motorman exactly the same number of empties. The same system of exchanging an equal number of loads for the same number of empties is followed on the main and gathering partings. Trip movement is controlled by junction-point block signals at Centralia also. Four electric switchthrowers are installed to operate derails on a hill leading up to the bottom. These derails are spaced just far enough apart to accommodate a locomotive and 31 cars, and when the loaded trip pulls up past the first derail, which normally is closed, the motorman operates a pull switch to open it. This is repeated with each derail in succession, until the trip clears the last installation on top of the hill, whereupon all the derails are closed at once by the locomotive trolley wheel striking a contactor.

Crescent Nos. 1 and 6 mines employ a combination of double tracks for empties and loads on main routes, supplemented by single-track lines with passing tracks or block signals at junction points. Block-signal installation, of course, is not confined solely to junctions, as signals are installed at all other necessary points. Crescent No. 1 offers an example of double track (7,600 ft.) to a main junction point inside the mine, with single tracks from there on into the working sections and block signals at the main and subsidiary junction points. At Crescent No. 6, in addition, certain sections of the main line used by several locomotives are equipped with passing tracks protected by blocks. Electric switchthrowers are installed at the main junction in both Nos. 1 and 6 mines.

Main-line trips at Bell & Zoller mines are handled by 15- and 13-ton trolley locomotives as a rule, with some smaller units at certain operations, such as Crescent, where all gathering is done by mules. Zeigler No. 1 employs six Goodman locomotives (five 15-ton and one 13-ton) in main-line work. These locomotives are split into two groups of three. One group pulls from two partings, each of which is the base for two relay locomotives. The four relay locomotives based on the two partings in turn serve thirteen gathering locomotives changing for eight loading machines on the day shift. Similarly, the other group of three main-line locomotives serves three partings, in turn used by five relay locomotives serving a total of fourteen gathering locomotives and nine loading machines.

Seven Locomotives Used

Six 13-ton Jeffrey trolley locomotives and one 10-ton Goodman machine operate on the main line at Zeigler No. 2 mine, the latter pulling from one loading machine in an isolated section. The other six locomotives are divided into groups of two. One group serves another isolated loading machine and two relay locomotives pulling from eight gathering locomotives and four loaders. The second main-line group serves three relay machines with eight gathering locomotives and four loaders, and the third group the same number of relay units with ten gathering locomotives changing for five loading machines. The above is exclusive of equipment on small-crew loaders

used in driving entries—one on the day shift and the other on the night shift.

Two 15-ton Westinghouse locomotives handle main-line trips at Centralia No. 5, serving in turn five relay locomotives pulling from six gathering units serving six loading machines. These main-line units also handle pit-car-loader coal. Locomotives employed at the Crescent mines are as follows: No. 1—one 15- and one 10-ton Jeffry; one 12- and one 8-ton General Electric; and one 6-ton Goodman; No. 6—two 13-, two 10- and one 6-ton Goodman, and one 8-ton General Electric. These locomotives operate directly from the bottom to the panel partings, with the exception of one or two units at each mine serving in relay capacities.

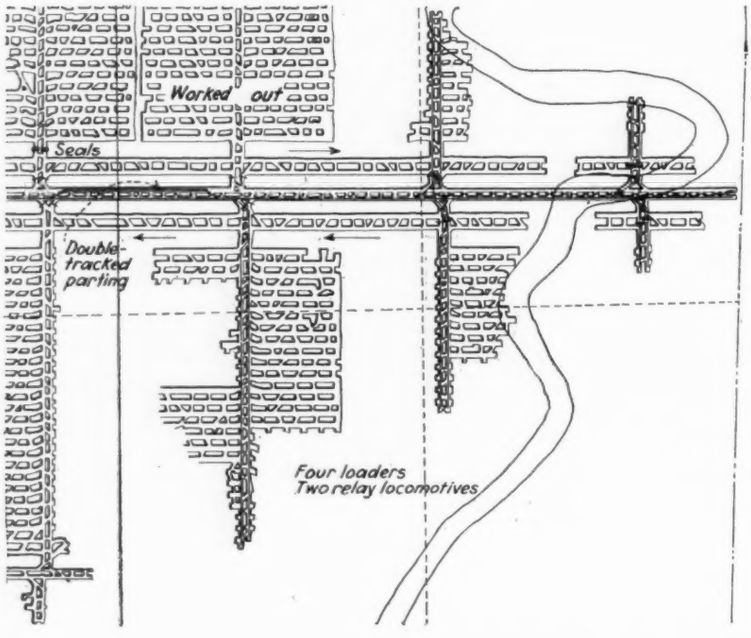
Rooms Limited to Twenty

Number of rooms per panel is limited to twenty per side at Crescent, where possible, to reduce tramming by mules, employed exclusively in gathering service. Partings are placed in the mouths of the panel entries and stub rooms (Fig. 1) are driven back toward the mains to recover the extra thickness of pillar that must be left to accommodate the parting. This placement of partings, previously installed along the cross entry between about every other set of panel entries, further reduces the tramming distance and prevents a number of drivers from congregating on a parting at one time. In addition, the stub rooms give a large tonnage of coal close to the parting. The new method of locating partings was adopted in 1932. Two 45s, placed as in Fig. 1, give access to the parting from both headings. Additional 45s are cut at intervals as the panel advances, for the convenience of cutting-machine crews and other employees and equipment.

A parting tender is employed for every four to six partings to oversee operation of the gathering haulage and assist the main-line locomotive crews. A main-line locomotive, in serving gathering partings, pulls up to a spur at some convenient point on the cross entry out by the group of partings and then comes to a stop, uncouples, runs in on the spur and lets the empty trip drift by under, if necessary, the control of the car brakes. The locomotive then couples onto the rear of the trip, heading it in to the partings and detaching empties as required. On the way out, the locomotive picks up the loads on the various partings. As a rule, by judicious selection of the spur-switch point it is possible in most cases to find a grade favorable for this maneuver close enough to the partings so that the empty trip does not have to be headed an excessive distance. Where a natural swag is not available to stop a trip after it is dropped it is held by the car brakes.

Partings for relay locomotives at the Zeigler mines usually are established in the aircourse. Fig. 2 is an example of this practice. Incidentally, the aircourse rooms shown in the figure, which parallel the main or cross entries and connect the panel entries, make it possible to eliminate all doors on the main lines. Each parting usually consists of two tracks, one for car storage and the other as a passing track for the haulage locomotive. Partings are installed at such intervals as will keep the maximum relay-locomotive travel under 2,000 ft. as a rule, although somewhat longer distances are necessitated at times. Uusually, a loaded trip is ready before the main-line locomotive is summoned, and as soon as the empties land the relay locomotives, usually two in number, split them up, each taking its share into the panel entries (see article beginning on p. 79 for description of car-changing methods and handling trips in panels). At Centralia No. 5 mine, partings are installed at convenient intervals in the back headings paralleling the main headings on main or cross entries.

Fig. 2—Working section, Zeigler No. 1 mine, showing parting location and room entry and development tracks



Higher-Capacity Cars Adopted

Replacement of original mine-car equipment with larger and improved units has been carried on steadily at Bell & Zoller mines since 1930. At Zeigler No. 1, the original cars were built of wood with plain bearings and 18-in. wheels. They were of the single-flare type with an inside length of 10 ft., an over-all width of 4½ ft. and a height of 47 in. Weight was 3,600 lb. per car and the capacity, mechanically loaded, 3.3 tons. Part of these cars were still in service when this article was prepared, but were scheduled for the discard upon receipt of the latest batch of 150 of the last type ordered. The second car used at No. 1, also of the single-flare type and wood construction, was made with a steel Z-bar between the bottom and the flare and also with a U-shaped all-through steel drawbar for additional strength and stiffness. Capacity of this car, mechanically loaded, is 3.3 to 3.6 tons. Weight is 4,200 lb.

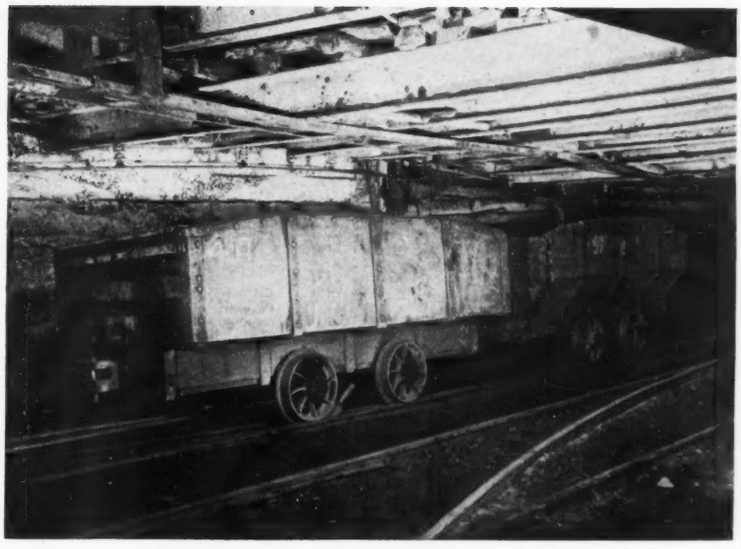
To reduce one of the handicaps encountered in mechanical loading—car-changing time—and also have a more reliable piece of equipment with a lower maintenance cost, a program of steel-car installation (American Car & Foundry and Mt. Vernon cars) was started shortly after Zeigler No. 1 was mechanized in 1929. The higher capacity of the first batch of these cars (4.0 tons) brought the average car

capacity for the mine up to 3.7 tons. The second steel car and the fourth to be installed at the property had a slightly larger capacity. The conventional body irons were retained, but these cars were improved by a reinforcing angle at the corners and corrugations in the ends (see photo, p. 91).

Still further changes in design were made in the last batch of 150 steel cars on order for Zeigler No. 1 when this article was written. Body irons are eliminated in favor of a corrugation in the sides, supplemented by channel-section stiffeners running down from the top to the corrugation, and from the bottom of the corrugation down onto the bench over the wheels. Inside length of the latest car is 10 ft. 2 in.; over-all width is 5 ft. 9 in.; and the height over the rail is 54 in. Wheel diameter is 18 in. Weight is approximately 4,700 lb., and the capacity mechanically loaded is 4.5 tons. A squeezer operating on the tops of the wheels is used to stop the cars before they enter the rotary dump on the bottom at Zeigler No. 1, limiting the amount the body can be dropped over the wheels. Likewise, the height is limited by the diameter of the dump circle. Installation of the last batch of steel cars will be accompanied by elimination of 135 of the original wood cars, bringing the total number of cars, both "big wood" and steel, to 818, and the average capacity, mechanically loaded, to approximately 4 tons.

Cars Cut Changing Time

At Zeigler No. 2 mine, opened in 1918, wood single-flare cars with a flat drawbar and a channel between the bottom and the flare were the first type to be used. Capacity is 3.75 tons, mechanically loaded. The next type, also wood, employed Z-bars and the U-shaped drawbar member, with spring draft gear. Over-all height, with 18-in. wheels, is 44 in.; over-all width is 5 ft. 3 in.; and over-all body length is 10 ft. Capacity is 3.75 tons. Replacement of the wood cars with Mt. Vernon steel cars began in 1936. Length and height of the steel cars are approximately the same as the second type of wood car, but the width is 4 in. greater, or the maximum which can be accommodated on the cage. Also, the bench on each side has been dropped as low on the wheels as possible. In the case of these steel cars, 150 of which were purchased, the usual body irons were installed, but the bottom is turned up at the end-gate end to prevent contact with the cage



Contrasts in mine cars at Zeigler No. 1 mine. In the rear is the earliest wood car with a capacity of 3.3 tons mechanically loaded, now scheduled for discard. In front is the next-to-last-type steel car, with a capacity of slightly over 4 tons.

tables in caging. Wooden bumper blocks are employed, with Monarch couplers. Capacity, mechanically loaded, is 4.3 tons. An additional 150 cars of this type were on order when this article was prepared at which time a total of about 650 cars of all types were in use. Eventually, steel cars will be used throughout, and it is expected that the reduced changing time will permit loading the same number per shift, thus increasing output from about 5,400 to 5,900 tons to close to 7,000 tons per shift if no hoist or other interruptions occur.

Anti-friction bearings were used from the start at Zeigler No. 2 mine. Original cars were equipped with the Hyatt-type bearing, with Timkens and Tysons (100 sets of the latter) on the last fifty of the Z-bar wood cars and all subsequent steel cars. In addition, the original bearings on 150 other Z-bar cars were replaced with Timkens. Hyatt bearings replaced the plain bearings on all wood cars originally so built at Zeigler No. 1, and were installed on 100 of the first steel cars. Subsequent cars have been equipped with Timken and Tyson bearings (100 sets of the latter type). All new steel cars at Zeigler mines are built with copper-bearing steel plates and are equipped with spring draft gear.

The year 1937 marked the completion of a program of replacement of the old wood cars having a capacity of 2.55 tons with copper-bearing steel cars having a capacity of 3 tons or more at Centralia No. 5 mine. Replacements by years were: 1929, 50 3-ton American Car & Foundry units; 1930, 50 Mt. Vernon; 1935, 50 Mt. Vernon; 1936, 50 Watt; 1937, 125 Mt. Vernon. Including losses, 314 steel cars are now in use. General dimensions are: maximum height over rail, 4 ft. $\frac{3}{8}$ in.; inside length, 8 ft. $6\frac{1}{2}$ in.; inside width, 5 ft. $\frac{1}{2}$ in. Timken-bearing wheels (16-in.) are employed. Inside door hinges were installed on 250 of the last cars purchased to increase capacity, otherwise limited by cage dimensions. These hinges have given entire satisfaction. Late cars also have the bottoms turned up at the door ends to prevent striking the cage tables, and are made with a pressed ridge in the end gate instead of an angle stiffener. This gives double the strength without taking up any more clearance. Red reflectors, or "cat eyes," have been installed on the corners of the last cars purchased.

Wood Cars Used First

Wooden single-flare cars holding 2,600 to 2,800 lb., hand loaded, originally were used at the Crescent mines of the Bell & Zoller group. At Crescent No. 6, these cars have been replaced, starting in 1932, with 450 Watt steel cars having wooden bumper blocks, brakes and 14-in.-diameter Timken-bearing wheels. Through axles were employed, and all wood was treated with creosote. Length was 10 ft. inside; width, 5 ft.; and height over the rail was 30 in. Hand loaded, these cars average 3 tons. Later 500 old-type wooden cars at No. 1 mine were replaced with 351 new steel cars having stub axles. Hand-loaded capacity is the

same; mechanically loaded capacity is 2.4 tons.

Heavy rail, treated ties and timber sets and grading to reduce resistance to trip movement characterize roadway construction standards at mines in the Bell & Zoller group. Main lines at all operations are laid with 60-lb. steel on treated ties. As intermediate haulage roads, under the general plan of operation, in which main-haulage units pull directly from gathering or relay partings, usually are unnecessary, except for occasional short-lived 40-lb. roads at Crescent mines, steel weight usually drops to panel and room figures immediately off the main lines. At the Zeigler mines, 35-lb. rail on wood ties is used in panel entries and in rooms up to the last car-changing switch. Beyond that point, 35- or 25-lb. rail on West Virginia steel ties is employed. At Centralia No. 5, panels and rooms are laid with 30- and 25-lb. rail on wood ties, with steel ties only under extension rails. Sixteen-pound rail, in view of mule haulage, is standard for panels and rooms at the Crescent mines. Wood ties are used except in mechanical-loading sections.

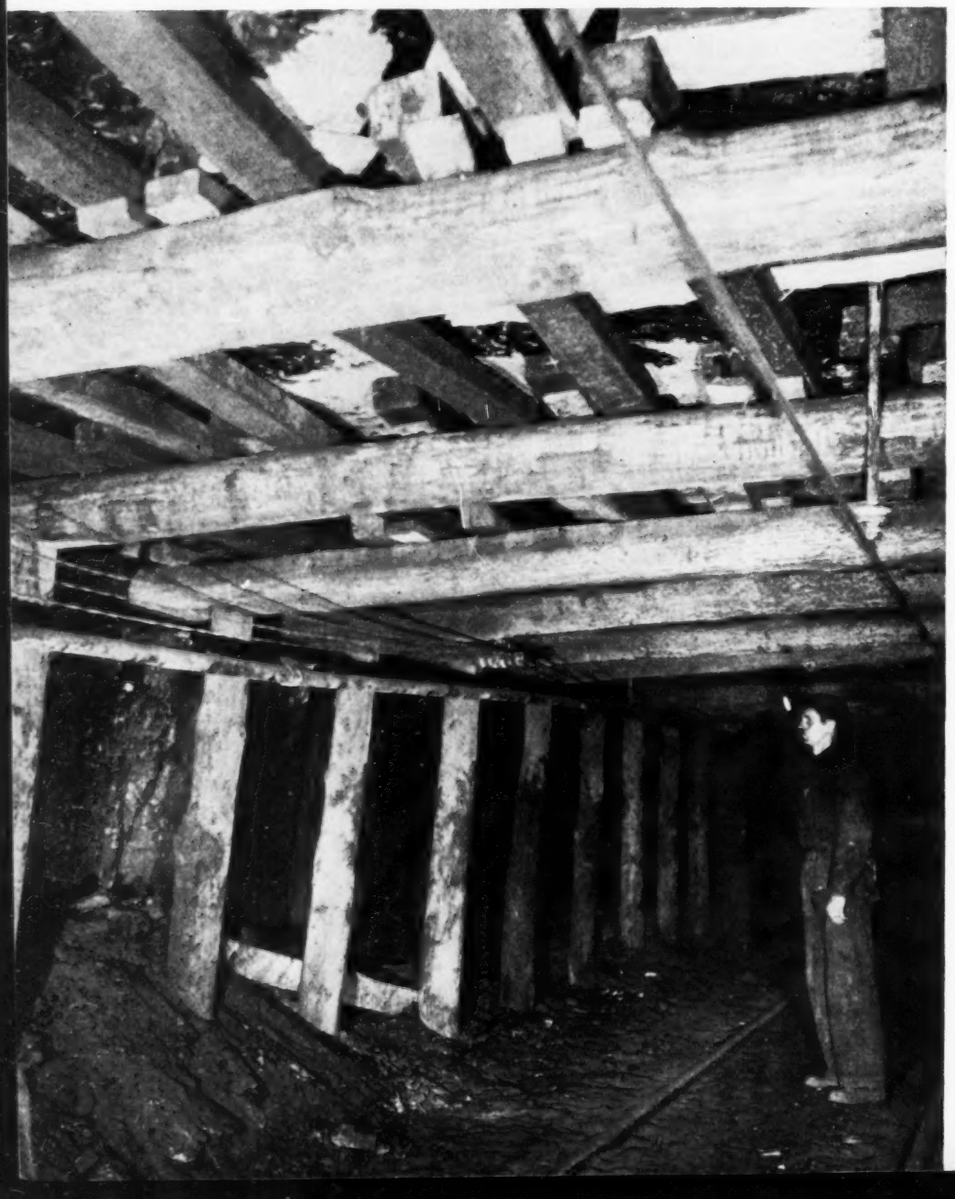
Systematic Grading Done

Coal areas opened by Bell & Zoller-group mines have only very slight general dips. At the same time, however, local changes in elevation result in relatively steep grades if the natural course of the bottom is followed. Consequently, grading is an integral part of roadway construction and at certain mines, notably the Zeigler operations, grading is extended even to the panel entries. Trip size also is influenced by grades. At the Zeigler mines, employing 15- and 13-ton locomotives, usual trip limits are 30 and 35 cars, with 25 cars on one stretch with a 2½-per-cent adverse grade in Zeigler No. 2. At Centralia No. 5, the limit is 31 cars in view of a 2.8-per-cent maximum grade onto the shaft bottom. Maximums at the Crescent mines are 30 cars on large locomotives and 25 to 30 cars on the smaller units.

With certain exceptions, main lines at the Zeigler mines are graded to a maximum of 2 per cent against the loads. Cuts vary up to 400 ft. in length, and as much as 10 ft. of bottom has been lifted in places, against 6 ft. of roof taken down in other places. All panel entries are graded so that they can be negotiated easily by an 8-ton locomotive with an 8- to 12-car trip—usually to a maximum of 4 per cent. Room track laid on wood ties also is tamped and leveled up to the point where the steel ties begin.

At Centralia No. 5, a major job was grading a 2,200-ft. stretch of track just off the bottom. This stretch, included in that part of the main line protected by the derails described above, was reduced to a maximum grade of 2.8 per cent, compared with 5 per cent before reconstruction. A maximum of 4 ft. of top was taken in places, and completion of the task permitted increasing trip size from 20 to 31 cars.

Main lines at Bell & Zoller mines are protected by treated timber sets. This view shows use of standard treated ties as lagging at Zeigler No. 1 mine.



Track Graded and Ballasted

Extensive track reconstruction also has marked transportation developments at Crescent Nos. 1 and 6 mines in the last few years. One project was grading, ballasting and draining since 1935 7,600 ft. of main line in Crescent No. 1. In 2,200 ft. of the new road, empty and loaded tracks were placed in the same heading; on the remainder, the tracks were laid in parallel headings. On the 2,200 ft., the top, which had fallen on the timbers, was taken up about 9 ft. to the solid sandstone. Sandstone recovered in this task was used for ballast. Approximately the same routine was followed on the other 5,400 ft. The grade on the 2,200 ft., in particular, was cut to less than 1 per cent against the loads, which made it possible to reduce the number of locomotives in service on this road from five to four. Reconstruction also involved the use of a box-type creosoted-wood drainage trough at the necessary points. This type of drain was adopted because of the decreased likelihood of its filling up and because it is easier to clean when this step becomes necessary.

Use of treated ties dates back to 1922 at the Zeigler No. 2 mine, when a batch was installed on the bottom. Some of these were removed in the course of construction work in 1935,

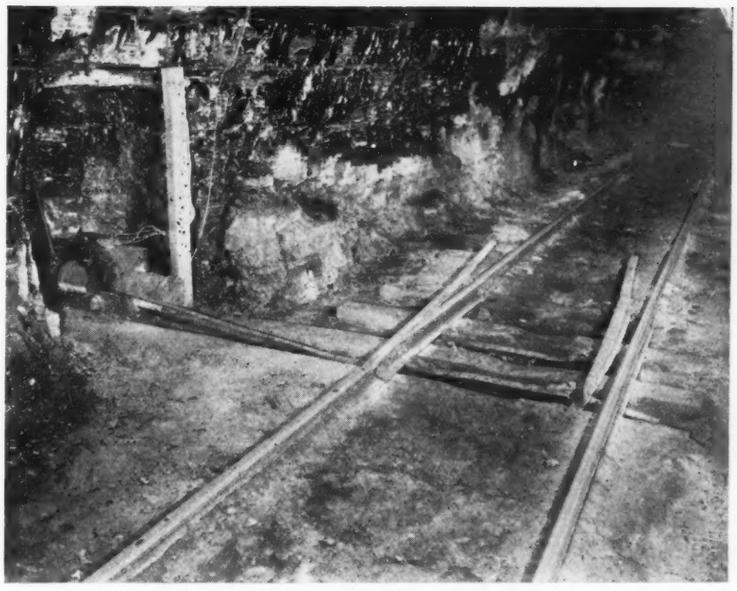
and when originally of oak were found to be in good condition. In 1927, Centralia No. 5 standardized on the use of 5x7-in.x6-ft. treated ties for 60-lb. main-line track and 4x5-in.x5½-ft. treated ties for all subsidiary haulage tracks up to the room entrances. Except for steel ties under extension rails, 3x4-in.x 5½-ft. untreated ties usually are employed for room tracks. Treating specifications are ½ lb. of dry zinc chloride per cubic foot of wood. No main-line ties have been removed because of decay.

Extensive use of treated ties of the same specifications as those for Centralia No. 5 started at the Zeigler mines in 1930. Original ties included some pine and gum. As a result of trouble with these types, the Zeigler mines standardized on oak only in 1931, none of which have ever been replaced because of decay. Life of an untreated main-line tie at best was four years. Temporary main-line track and all track in panel entries and in rooms up to and including the last changing switch, usually of 35-lb. rail, is laid on 4x6-in.x5½-ft. oak ties at the Zeigler operations. At No. 2, however, 5x5-in. ties were employed until the summer of 1936.

Treated Ties Last Longer

The principle of treated ties in panel and room service as well as on main lines was adopted at Zeigler No. 2 in 1932. At that time the mine still was on the hand-loading basis, and experience showed that the life of green untreated ties in panel entries and rooms usually was less than eighteen months. If seasoned, however, well over eighteen months could be expected. At best, however, substantial replacements were necessary before panel entries —and frequently certain long rooms —could be worked out, and treating was adopted to reduce the resultant expense and at the same time permit a tie to be used over and over until rendered useless by continued spiking or other mechanical damage. While life of place is not so vital a factor under mechanical loading, it is felt that there still is a slight margin in favor of the treated tie for panel entries and rooms, and consequently their use has been continued.

Use of a 5x6-in.x5½-ft. zinc-chloride-treated tie for main lines was started at Crescent Nos. 1 and 6 mines in 1932, and to date none have been removed because of decay, although a number have been taken up and shifted to other locations. Except in mechanical-loading sections, where steel ties are employed in rooms, panels and rooms at the Crescent mines are laid, as a rule, with 3x4-in. untreated ties. To gain height, a maximum of 18 in. of bottom 6 ft. wide is lifted on main and cross entries, dropping down to 12 in. to the top of partings and then to 10 in. on panel headings, etc. In rooms, the ties are sunk to bring the rail to ground level, the mules, where necessary, stepping between the ties for height.



Electric switchthrower on one of the derails at Centralia No. 5 mine

Frog sizes at the Zeigler mines are: main lines, No. 4; 35-lb. rail installed on entries, No. 3½, both of the riveted-plate type. West Virginia right- and left-hand turnouts with No. 2½ frogs and integral filler rails are employed in rooms. All 35-lb. turnouts are fitted with 4½-ft. switches (or latches), and all turnouts are equipped with bridles, with two on more important installations. At Centralia, main lines are laid with No. 4 frogs, with No. 3s on panels. Rooms customarily are necked on a 45-deg. angle to decrease the curve radius and enable equipment to get in and out more easily. West Virginia turnouts are employed.

Main lines customarily are ballasted with mine material, except in certain cases, such as Crescent, where sandstone or other hard rock is made available. Drainage seldom is a problem, except at Crescent, where it is taken care of as described above. These conditions facilitate the use of zinc-chloride-treated ties and timbers. Track crews are being supplied with lightweight tools, primarily "Umeco" aluminum-alloy units, to increase their efficiency and reduce the possibility of injury, which otherwise would be present in handling heavy benders and punches. Fishplating of all joints, including joints of extension rails, is an efficiency measure, particularly at the Zeigler and Centralia operations, and consequently punches are a much-used tracklaying adjunct.

Timber Sets Most Used

Timber sets are the most generally used form of supports along haulage roads at mines in the Bell & Zoller group. These are supplemented where unusually wide spans are encountered, either along the road or at junction points, by concrete walls and/or points and steel I-beams. Eight-foot legs are standard at Zeigler Nos. 1 and 2 mines. At No. 1, where spans are 16 to 18 ft., the largest bar possible to purchase and install is used, with two legs under each end. Steel and concrete are used on wider spans at No. 1, and on over 16-ft. spans at No. 2. All 16-ft. bars at both mines have a minimum tip diameter of 8 in. All 14-ft. and 12-ft. bars, the latter the shortest normally employed, have a minimum tip diameter of 7 in. Pine bars and legs are used at both of the Zeigler mines.

Timber sets usually are installed on approximately 5-ft. centers. Special 3x5-in.x5½-ft. oak lagging is used where the clearance over the bar will not accommodate the regular lagging. Where clearance is suffi-

cient, however, standard 5x7- or 4x6-in. wood ties 6 or 5½ ft. long, respectively, are used for lagging. At No. 1 mine, the general practice is to crib up to the top of high falls, on the ground that there is less possibility of cribbing being displaced by roof movements, etc., whereas at No. 2 the practice is to set auxiliary sets on top of the regular sets where the roof is 4 ft., or half a leg length, over the top of the bar of the regular set. This system is preferred at No. 2 because it facilitates ventilation clear to the top of fallen places and reduces the surfaces on which dust can collect.

Starting in 1928 at Zeigler No. 2 mine, and in 1930 at No. 1, zinc-chloride-treated timber has been installed on all main lines, in all aircourses and in all panel entries up to the point where the main panel seals are to be installed. The latter practice makes it possible to hold the panel mouth open until an opportunity to install the permanent seals is available. Depending upon operating considerations, this may be three or four years after the panel is worked out, in which time untreated sets probably would be destroyed, as their average life is not over three years, as a rule. On the other hand, only three treated sets have been removed at Zeigler No. 2 since 1928, all due to breakage because of weight and not decay. Treated lagging, whether special lagging or regular track ties, is used with all treated-timber installations. Both Zeigler mines follow the practice, when roof breaks are encountered, of going in and cleaning them out to the solid and then retimbering to the top of the fall.

Track in all entries is laid on the center lines of the headings, which are supposed to be driven 12 ft. wide. Clearance from the ends of the ties to the ribs therefore is at least 36 in. in all cases. All power and trolley lines are installed on the side of the track opposite the crosscuts, with telephone and signal lines on the opposite side. This practice also is followed at the Centralia and Crescent mines, and consequently all locomotives are equipped with two poles and Jeffrey automatic transfer switches for changing from one side to the other, as conditions warrant.

Conditions at Centralia No. 5 mine are such that main roads must be timbered only occasionally. At Crescent Nos. 1 and 6 mines, haulways, where necessary, are timbered with 3-piece sets as a rule, with steel-rail bars at junctions or points where height is limited. Timbering standards call for 30 in. of clearance between legs and cars. Legs are purchased in 6-, 7-, 8- and 9-ft. lengths, with a minimum tip diameter of 6 in. Bar lengths are 10 12, 14, 16 and 20 ft. Bars up to 14 ft. must have a minimum diameter of 6 in.; over 14 ft., 12 in. Sets are placed on 5-ft. centers in case a number must be installed. Treated permanent timbers have been used since 1931, with no losses to date from decay.

PREPARATION

+ "Superwashed Genuine Zeigler Coal"

ROUNDING OUT its program of complete mechanization of underground and surface operations at the Ziegler Nos. 1 and 2 mines, the Bell & Zoller Coal & Mining Co. operates one of the largest bituminous mechanical cleaning and screening plants in the United States. With a rated capacity of 1,000 tons per hour, this plant has loaded for shipment as high as 7,300 tons of mechanically cleaned and sized Illinois No. 6 coal in seven hours, equivalent to approximately 7,700 tons of raw mine output. The plant was built at No. 2 shaft and in addition to coal from this operation also prepares the output of Zeigler No. 1 mine, two miles to the east. When both mines are operated on the same day, No. 2 coal is prepared on the first shift, and No. 1 coal, brought in in railroad cars, is prepared on the second shift.

Construction of the Zeigler preparation plant, the home of "Superwashed Genuine Zeigler Coal," was an outgrowth of both changing market conditions and a decision to extend the principle of mechanization of loading underground to No. 2 mine. At the time the latter was taken up for consideration, appreciation of the benefits of mechanically cleaned coal had increased to the point where construction of a modern plant was definitely indicated to meet the higher standards set up by a number of coal purchasers. At the same time, a cleaning plant also would solve one of the major problems growing out of mechanization underground: lack of opportunity for cleaning coal in the working place.

At No. 1 mine, where mechanization of loading got under way in 1929, the problem of eliminating the extra refuse resulting from lack of an opportunity to clean underground was solved, pending construction of a mechanical plant, by remodeling the tipple, built in 1904, in 1930. At the same time the number of pickers was increased from 8 to 10 to 44. But even with this step, wide fluctuations in the impurity content of the mine output made maintenance of uniform shipments of the larger sizes difficult, while the smaller sizes naturally received no cleaning at all because of the difficulty of adequately hand-picking them. Consequently, an investigation of mechanical-cleaning possibilities was begun and culminated in the new Zeigler plant, which started operating in 1935 a few months before the introduction of loading machines at No. 2 mine. The new plant was built adjacent to the old No. 2 tipple, later razed, which was erected in 1918. A like fate befell the No. 1 tipple, which was replaced by a storage bin and railroad-car loading facilities. In both cases, the old tipples, with remodeling, were considered well abreast of usual practice at the time mechanical loading was adopted.

Zeigler preparation plant—one of the largest bituminous operations in the country. At the left is the railroad-car-dumper for coal from No. 1 mine. No. 2 headframe is between the dumper and the power-plant stack

The principal impurity encountered in raw Zeigler coal is the characteristic Illinois No. 6 "blue band," which varies from ½ to 2 in. in thickness. Fireclay picked up from the bottom is another impurity, and where the top coal usually left in place breaks, some of the overlying drawslate may be loaded out. Another undesirable element occasionally encountered is "blackjack," closely resembling coal. Sulphur content averages close to ½ per cent. Although the impurity content of the coal is low, as evidenced by a preparation-plant rejection of around 5 per cent, Zeigler coal nevertheless offers a difficult cleaning problem, due to the fact that a substantial proportion of the impurities have a specific gravity very close to the cleaning gravity of 1.40. This is particularly true of the fraction from 1½ to 6 in. in size, all of which is run to one washing unit for cleaning. On the other hand, little difficulty is encountered in washing the 1½x⅝-in. fraction or in air cleaning the resultant ⅝-in. fines.

Zeigler preparation-plant design provides for loading eight primary sizes, as follows: hand-picked 6-in. lump, washed 6x3-in. furnace lump, 3x2-in. small egg, 2x1½-in. stove, 1½x¾-in. chestnut and ¾x⅝-in. pea; air-cleaned ⅝-in. x 10-mesh buckwheat, or stoker; and 10-mesh dust. Raw carbon, or minus ⅝-in. coal, run directly to the railroad car, is another size frequently loaded, and provision also has been made for producing 1-in. screenings at will by crushing 2x1½-in. stove or 1½x¾-in. chestnut, part or all, and combining the crushed product with the sizes under ¾ in.

Except when 1-in. screenings are being made, combinations of any two or more of the eight primary sizes can be shipped. On the basis of shipments in June, 1937, the calculated size percentages of the raw feed to the plant were: lump, 13.85 per cent; furnace lump, 16.20 per cent; small egg, 11.19 per cent; stove, 5.31 per cent; chestnut, 14.53 per cent; pea, 11.80 per cent; and carbon, 27.12 per cent.

All sizing in the Zeigler preparation plant, designed and built by the Robins Conveying Belt Co., is done on grizzlies or vibrating screens. A magnetic pulley is provided to remove tramp iron from the 6x0-in. raw-coal fraction prior to preparation, and a second such pulley is used to separate iron from refuse from the coarse-coal washer prior to crushing and recirculation. A shaking picking table is installed for cleaning 6-in. lump; 6x1½-in. coal is washed in a 16½-ft. Chance cone; 1½x⅝-in. coal is washed in a second 13½-ft. cone; and ⅝x0-in. coal, first screened to remove the 10-mesh dust, is run to eight Stump "Air-Flow" cleaners. Middlings from the eight air cleaners are retreated on two additional units, which also receive their own middlings for final separation. All sizes are loaded over booms equipped with Viking spray nozzles served by Viking pumping and heating equipment for dustless treating by the hot-oil or wax method. An Ottumwa box-car loader, with hot-oil sprays in the feed chute, permits box-car shipments of the larger coal sizes down to and including stove.

Coal from Zeigler No. 1 mine, as noted above, is cleaned on the second shift when both mines are operated the same day. The No. 1 mine skips dump into a 50-ton storage bin, from which the coal is drawn off into railroad cars. Car storage space at No. 1 accommodates 60 empty cars and 75 loads. In addition, tracks for 38 loaded cars are provided on the empty side at the Zeigler preparation plant. To move raw mine-run from No. 1 to the preparation plant, Bell & Zoller employs 150 railroad cars and three standard-gage locomotives, all self-owned. At the preparation plant, the railroad cars are dumped into a 70-ton bin by a Mead-Morrison dumper. From the bin the coal is fed out by two plate feeders onto a 54-in.-wide belt conveyor, 280 ft. long between pulley centers and set on a pitch of 18 deg., leading to the top of the preparation plant. A Merrick "Weightometer" is employed for continuous weighing of the No. 1 coal on the belt, which has a capacity of 1,000 tons per hour. Sand for the cleaning cones also is dumped with this same equipment and is carried up on the belt to a bypass leading to the sand bin, as

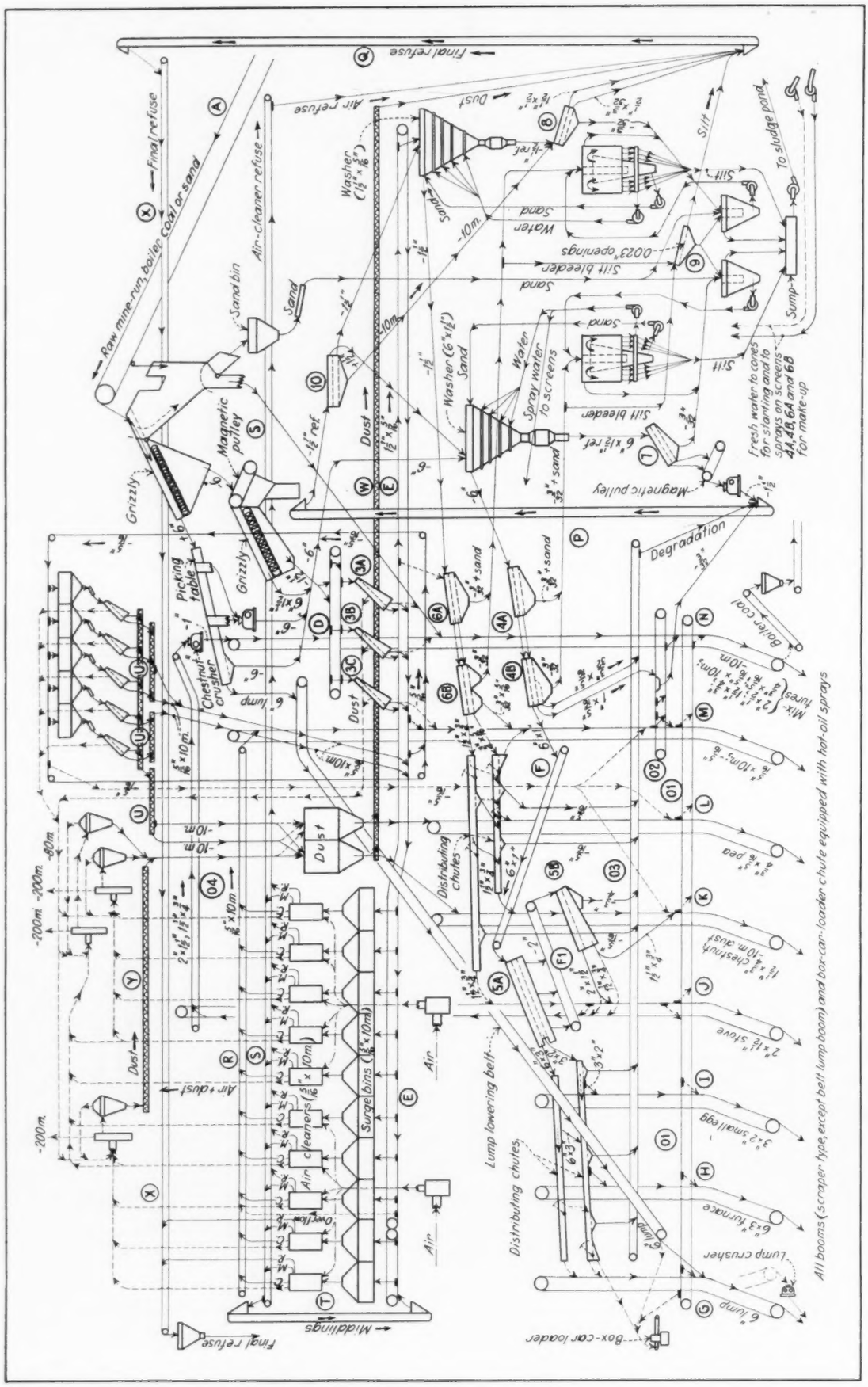


Fig. 1—Flowsheet, Zeigler preparation plant

indicated diagrammatically in the flowsheet, Fig. 1.

Coal from No. 2 mine, equipped with self-dumping cages, is discharged into a weigh basket and then into a small surge bin, from which a belt feeder moves it out onto a 54-in. cross belt. This belt in turn discharges onto the main belt over pivoted fingers which permit the minus 6-in. material to fall through first and act as a cushion for the lumps. A gate under the weigh basket in the No. 2 headhouse permits rock or mine-run coal to be diverted to railroad cars. Rock is hoisted only occasionally during the working shift, and this gate is used primarily as a means of permitting uninterrupted operation of the hoist during cleaning-plant stoppages by diverting raw mine-run to cars which then are dumped as required with the Mead-Morrison dumper and serve as a source of supply for the cleaning plant during hoist interruptions. The dumper also makes it possible to return crushed lump to the plant for repreparation.

Boiler Coal Also Handled

The pivoted fingers mentioned above permit coal coming up the main belt to pass under the cross-conveyor discharge chute, and thus allow operation of both belts at the same time. At times when the cleaning plant is not in operation, cars of boiler coal also may be discharged through the dumper and started on its way through the conveyor system to the power-plant boiler room, which ordinarily is supplied from the preparation plant.

At the head of the main conveyor, a gate allows sand and boiler coal to be bypassed to a chute system, in which a second gate is installed to direct the two products to their respective destinations. This chute system also receives coal from the belt-cleaning brush and passes it on to the screenings boom, *N* in flowsheet. Raw mine-run, crushed lump, etc., however, pass over the bypass gate to a "Cataract" grizzly, 5 ft. wide and 7 ft. long. This unit separates the feed into plus and minus 6-in. fractions. The lump goes onto a 72-in.-wide picking table equipped with four refuse chutes and two Westinghouse 400-watt mercury lighting units. Space is provided for eight pickers and a supervisor. Picked lump passes over a 6-in. bar screen in the lower end of the table for removing breakage and from there onto a 54-in. lowering belt which takes it to the lump boom or to the box-car-loader chute.

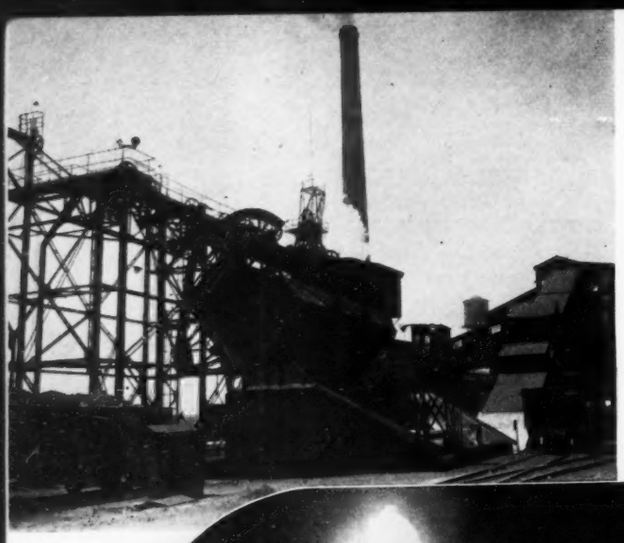
Refuse from the picking table drops into a Jeffrey single-roll crusher, which breaks it down to minus 6-in. The crusher product then is run with 6x1½-in. raw coal to the 16½-ft. cleaning cone. The 6x1½-in. fraction is derived from the material through the first grizzly, which is passed over a 5-ft. Stearns magnetic pulley to remove tramp iron. The short belt which carries the coal over the pulley discharges onto a second "Cataract" grizzly, 5 ft. wide and 14 ft. long, where the 6x0-in. size is separated into 6x1½-in. and 1½x0-in. fractions, the former going to the 16½-ft. coarse-coal cone.

The minus 1½-in. coal from the secondary grizzly then is split among three 6x14-ft. Robins "Gyrex" screens (*3A, B* and *C*) by a scraper-type distributing conveyor, *D*. These screens produce 1½x$\frac{5}{16}$- and $\frac{5}{16}$x0-in. sizes. The former goes to the 13½-ft. washing cone on the top strand of Flight Conveyor *E*, while the $\frac{5}{16}$x0-in. raw carbon usually goes to a gravity-discharge elevator as the first step on the road to the air-cleaning plant. Raw carbon from the three screens, however, can all be diverted through chutes to the carbon boom, *M*, or partly to Booms *M* and *N*.

Both the washing cones in the Zeigler plant operate on a specific gravity of 1.40. Refuse from the coarse-coal cone is discharged onto a 5x10-ft. "Gyrex" desanding screen with two decks. Material through the top deck (6x1½-in.) falls onto the lower deck, where final desanding at 3/32 in. is accomplished. Material over both decks is passed over a Stearns magnetic pulley and then into a Pennsylvania single-roll crusher for reduction to minus 1½ in. The crusher product then is elevated to a 3½x10-ft. double-deck Symons horizontal vibrator. Plus 1½-in. material—primarily flats that have passed through the crusher—pass over the top deck of the screen into the coarse-coal cone for re-treatment. In this way flats are recirculated until they are broken down along with the other refuse to free any recoverable coal values. Minus 1½-in. material through the upper deck of the Symons screen, after removal of the 10-mesh material on the second deck, is chuted to the 13½-ft. cone for re-treatment.

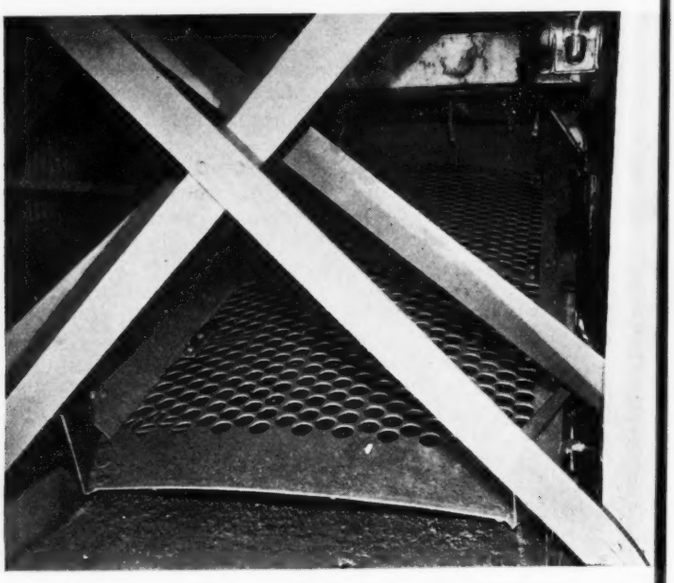
Refuse from the 13½-ft. cone is desanded on a 5x12-ft. "Gyrex" screen, which also receives the 10-mesh material through the lower deck of the Symons screen. Everything above 3/32 in. passes from the "Gyrex" decks to the refuse-elevating conveyor, *Q*, en route to the refuse bin. As in the case of the 16½-ft. coarse-coal cone, minus 3/32-in. material, mostly sand, goes to a make-up-sand sump, from which it is raised to the cone-supply sump by a 1,000-g.p.m. sand pump. It will be noted that all refuse leaving the washing plant is less than 1½ in. in size, due to crushing of the 6x1½-in. refuse to reclaim coal. That this reclamation pays is indicated by the fact that the float in the final 1½-in. refuse averages about 0.5 per cent, compared with about 1.6 to 1.7 for the 6x1½-in. refuse from the coarse-coal cone. Also, this reclamation, plus

Loading booms are equipped for hot-vapor wax or oil treatment of coal before shipment. Sprays and hoods are arranged to catch the finer sizes while in the air. On the larger sizes, however, hoods are placed on top of the booms, as shown at the left, and the sprays are directed down on the coal.



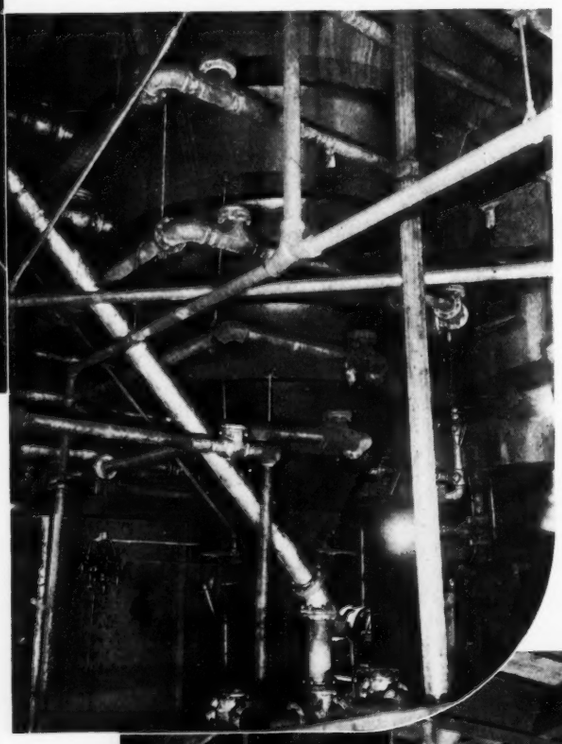
Railroad-car dumper in action on coal from No. 1 mine

All screening is done on vibrators at Zeigler. This view shows perforated plate on the 5A unit for furnace and small egg

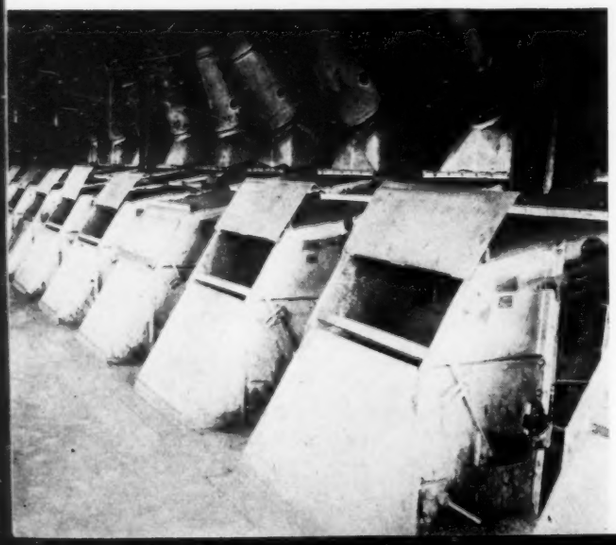


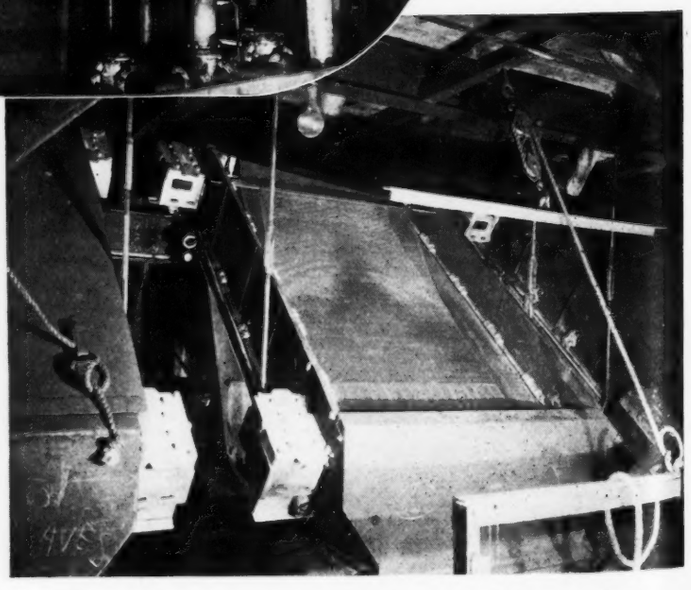
Mercury-vapor lamps illuminate the picking table for 6-in. lump

Two cones, one of which is shown here, wash all coal from 6 down to 5/16 in.



Air cleaners are employed for removing impurities from 5/16-in. x 10-mesh coal





One of five electric screens for separating 10-mesh fines from 5/16 x 0-in. raw coal prior to cleaning (the dust hood is raised to show cloth)

facilities for reclaiming and shipping all dust coarser than 200-mesh has resulted in a substantial reduction in loss in preparation.

Cone-supply sumps also serve as mediums for separating fine coal from the sand, as indicated in the flow-sheet. Sand collecting in the bottom of the inner cone of each sump is pumped back to the 16½- and 13½-ft. cones, respectively, by 2,000- and 1,500-g.p.m. sand pumps. Water and minus 3/32-in. silt overflowing the cone feed out into a manifold from which part of the silt and water are bled off to a sludge sump, from which it is pumped to a sludge settling pond by a 1,000-g.p.m. sludge pump. The remainder of the water and fines is pumped back to the manifolds serving the cone rings by 5,000-g.p.m. circulating pumps. All the above pumps are Morris manufacture. Water overflowing the make-up sumps joins the silt and water from the supply-sump manifolds in the sludge sump.

Two Screens Desand Coal

Cleaned coal from the 13½-ft. cone (1½x$\frac{5}{16}$ in.) is desanded and separated into 1½x¾-in. chestnut and ¾x$\frac{5}{16}$-in. pea on two 5x12-ft. "Gyrex" screens. Most of the desanding is done on the upper screen, *6A*, while desanding is completed and the coal is sized on the lower screen, *6B*. Minus 3/32-in. material through the bottom decks of the two screens goes back to the 13½-ft. cone-supply sump, first passing a bleeder point where part of the silt is taken out. Coal from *6B* screen is discharged onto two shaking distributing chutes with flexible wooden-arm hangers, one chute set over the other. These chutes carry the two sizes to their respective loading booms and also are arranged to permit mixing the two sizes or for passing the 1½x¾-in. chestnut to the stove boom, *J*, and the ¾x$\frac{5}{16}$-in. pea to the carbon boom, *M*. Chestnut is run to the stove boom only for purposes of crushing for making 1-in. screenings. In this case the chestnut boom, *K* is used for loading dust. If *K* boom is in use, and the ¾x$\frac{5}{16}$-in. pea is being used in making a screenings combination, the dust may be diverted to *L* boom. If both booms are in use, the dust may be loaded through chutes into cars under the bins.

Coarse coal from the 16½-ft. cone, which is primarily 6x1½-in. in size but also includes some smaller material obtained from the crushed pickings and degradation from the lump picking table, is desanded on two 6x12-ft. "Gyrex" screens, *4A* and *4B*. The lower screen, *4B*, also takes out minus 1-in. material and separates it into 1x$\frac{5}{16}$- and $\frac{5}{16}$x3/32-in. fractions. The larger goes to the top strand of the auxiliary mixing conveyor, *O2*, where it passes over a 3/32-in. wedge-wire section and then either to Boom *M* or onto the bottom strand of the conveyor to Boom *N*. Material through the wedge wire goes to the boot of Elevator *P*, receiving crushed 16½-ft.-cone refuse.

Material through the bottom decks of screens *4A* and *4B*—minus 3/32-in. in size—goes to the 16½-ft. cone-supply sump, after passing a silt bleeding point. Silt bled out of the flumes from both Screens *6A* and *6B* and *4A* and *4B*, goes to a sand-recovery vibrator set over the make-up-sand sumps. This screen is equipped with cloth having 0.023-in. openings. Water and material through the cloth go to the make-up sumps, while the silt retained on the cloth is discharged to the refuse. By bleeding the system in this manner the silt content is kept down to reasonable limits. Sprays on Screens *4A* and *4B* and *6A* and *6B* are supplied with make-up water, in addition to the regular supply, by two 500-g.p.m. Deming pumps at the clear-water storage pond. This pond receives water by gravity from the sludge-settling pond and the pumps are used in alternate weekly periods. They also supply fresh water for breaking up the sand and filling the cones in starting.

The 6x1-in. coal from the desanding screens *4A* and *4B* is elevated on a 54-in. belt conveyor to a 6x14-ft. "Gyrex" screen, *5A*, equipped with perforated plate for making 6x3-in. furnace lump, 3x2-in. small egg and a minus 2-in. resultant. The furnace and small egg are discharged onto another pair of shaking distributing chutes arranged with gates, center channels and degradation screens for distributing the two sizes to their respective loading booms, for mixing them with themselves and with the 6-in. lump and for running either size to chutes to the box-car loader. Degradation from both this and the other set of distributing chutes, from the screens and from other sources falls onto a flight-type degradation conveyor, *O3*, which discharges into the boot of Elevator *P* (handling cone refuse).

Minus 2-in. coal through the bottom deck of Sizing Screen *5A* falls onto an auxiliary belt conveyor which elevates it up to the head of a 6x12-ft. Robins "Vibrex" screen, where it is separated into 2x1½-in. stove, 1½x¾-in. chestnut and minus ¾-in. degradation. The chestnut, in case 1-in. screenings is being made, is run onto the bottom strand of Boom Conveyor *J*, where it joins the chestnut off the end of the upper distributor following Screen *6B*. Otherwise, the chestnut is bypassed through a gate to Boom *K*. Chestnut discharged onto the bottom strand of Conveyor *J* is carried back to an auxiliary flight conveyor, *O4*, which in turn discharges it into a Pennsylvania single-roll crusher for reduction to minus 1-in. The crusher discharges onto Boom Conveyor *N*, where the minus 1-in. size is joined by the smaller sizes made in the normal course of screening. Stove similarly

Part of the Zeigler testing laboratory, primarily devoted to testing and analysis of Zeigler coal.

may be routed around to the "chestnut" crusher.

Provision also has been made for breaking down 6-in. lump either for shipment as minus 6 in. or for re-preparation in the plant. Crushing is done in a double-roll Link-Belt breaker installed on a platform at the end of the lump loading boom, which discharges into the crusher in raised position. Crushed coal drops into a railroad car, which can be shifted back to the dump and discharged onto the main raw-coal belt if desired.

Minus $\frac{7}{16}$-in. coal to be air-cleaned is discharged, as pointed out above, into a gravity-discharge elevator which lifts it up and distributes it to a surge bin over five 4x8-ft. Tyler 400 electric screens. Feeders ahead of each screen move the coal out of the bin. Provision also is made for bypassing the raw $\frac{7}{16}$-in. coal, or carbon, to a branching chute leading to Boom *K*, *L* or *M*, if desired. The five screens separate out the minus 10-mesh dust, which is collected and conveyed to the dust bins by two screw conveyors. The $\frac{7}{16}$-in.x10-mesh coal over the screens is collected by two additional screw conveyors, which feed into chutes leading to the lower strand of Flight Conveyor *E*. Two chutes are provided, one feeding onto one side of the conveyor and the other onto the other to equalize the load on both sides.

Conveyor *E* distributes the $\frac{7}{16}$-in.x 10-mesh coal to a continuous surge bin ahead of the eight 4x10-ft. Stump primary cleaners. In case of overload, a bypass permits scraping the excess into a chute to the clean-coal collecting belt, *R*. The primary cleaners produce three grades of material: clean coal, middlings and refuse. Refuse is discharged onto the top strand of a flight conveyor, *S*, and eventually into the refuse-elevating conveyor, *Q*. Middlings are discharged onto the bottom strand of Conveyor *S*, from which they drop into the boot of the middlings elevator, *T*. The elevator in turn discharges into a surge bin feeding two Stump re-treatment cleaners.

Air for the operation of the ten Stump cleaners is supplied by two American Air Filter blowers. Air and dust from the cleaners go to three Rotoclone dust precipitators designed to recover all but the minus 200-mesh material in the "clean air" fraction to the atmosphere. The "dusty-air" fraction goes to dust collectors, one for each Rotoclone. Dust from the collectors is run to the dust bins, while the air is recirculated to the Rotoclones. The Rotoclones, as indicated in the flow-sheet, also receives the dust taken off the *3A*, *B* and *C* and Tyler groups of screens to increase recovery.

The Zeigler preparation plant, when working two shifts, is operated with the following standard crews: first shift, including operating, maintenance and float-and-sink men, 45; second shift, 45; third shift, maintenance, 17 men, or a total of 107 for a working day of two cleaning and one maintenance shifts. Screens are equipped as follows: Tyler 400, "Ty-Rod" cloth; *5A* sizing screen perforated plate; desanding and dewatering screens (*4A, 4B, 6A, 6B, 7, 8, 9* and *10*), No. 35 "Ton-Cap" galvanized cloth; all other screens, "Gyraloy" cloth. The empty storage yard accommodates 123 railroad cars, in addition to the tracks for mine-run cars from No. 1. A total of 106 cars can be stored on the loaded tracks, in addition to space for 70 empties used in bringing mine-run from No. 1. Counterweighted car retarders control the cars during loading. All scraper-type boom conveyors are equipped with a slide gate (see p. 140) for diverting coal from one car to another while changing loads for empties.

Including heating units and boom hoists, but excluding the railroad-car dumper, the Zeigler preparation plant is operated by a total of 94 electric motors. Motor and drive details, as well as the various sequence control systems employed, are detailed in the article beginning on p. 102.

Sampling and analysis for plant-control and general information purposes is handled by sink-and-float men and laboratory technicians. Two float-and-sink men, who gather the samples and also run float-and-sink and screen tests, are employed each shift at the preparation plant. Chemical analysis and special studies are carried out in a full-scale general laboratory staffed by a chief chemist and four assistants. These men are concerned primarily with coal testing but also handle other testing work which comes up in the operation of the two Zeigler mines.

Sizes sampled, points where samples are taken, sizes of samples, sampling intervals, and testing objectives are summarized in Tables I and and II, Table I dealing with general information and Table II with information for plant-control purposes.

Table I—Part I of Testing Schedule at Zeigler Preparation Plant; General Information; to Be Completed Every Four Operating Shifts

Size	Place Where Sample Is Secured	Number Screen Analyses	Number Proximate Analyses
6x3-in. washed	End H boom	2	1
3x2-in. washed	End I boom	2	1
2x 1½-in. washed	End J boom	2	1
1½x¾-in. washed	End L boom	2	1
1x⅜-in. washed	End L boom	2	1
Buckwheat	End M boom	2	1
10-mesh dust	End K boom	2	1
2-in. cleaned screenings	End N boom	2	1
2-in. dedusted screenings	End N boom	2	1
1½-in. cleaned screenings	End N boom	4	2
1½-in. dedusted screenings	End N boom	4	2
1-in. cleaned screenings	End N boom	4	2
1-in. dedusted screenings	End N boom	4	2
Super-X domestic stoker	End M boom	4	2
Crushed chestnut*	End N boom	2	None
Crushed chestnut*	End N boom	2	None

* Only for check on crushing results

Table II—Part II of Testing Scheduie at Zeigler Preparation Plant; Plant Control; to Be Completed Every Working Shift

FLOAT-AND-SINK ANALYSIS

Size	Where Sampled	Increments: Size	Increments: Number	Increments: Interval	Size of Sample
3x2-in. W	Chute anead Boom I	20 kg*	3	10 min.	60 kg.
1½x⅜ W	End 6A screen	20 kg*	2	15 min.	40 kg.
6x1½-in. ref	End screen 7	20 kg*	3	.....	60 kg.‡
1½x⅜-in. ref	End screen 8	20 kg*	2	.....	40 kg.‡

SCREEN AND ASH ANALYSIS

Size	Where Sampled	Number Analyses: Screen	Number Analyses: Ash
Raw carbon	Equal amounts from each feeder to Tyler screens	None	2
6x1½-in. refuse	End screen 7	None	2
1½x⅜-in. refuse	End screen 8	None	2
Air-cleaned buckwheat	End Belt R†	2	2
Total Tyler dust	End dust screw	2	1
No. 1 Tyler dust	Beneath screen	2	None
Raw buckwheat	End each Tyler screen	2	None
Total buckwheat	Sampling gate, bottom E conveyor ahead surge bins	1	1
Dry-plant refuse	Refuse conveyor	0	2

* One tub full. † Eight increments, 15 to 20 minute intervals. ‡ Four per shift.

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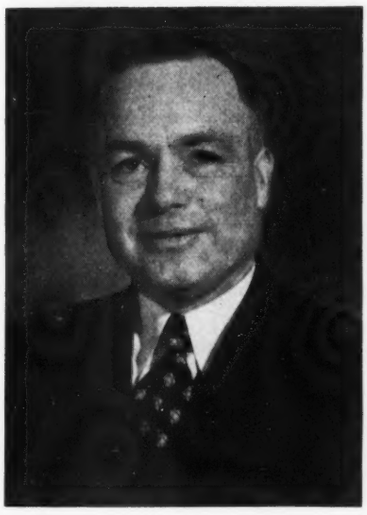


J. M. JOHNSTON
Assistant General Manager
Bell & Zoller operating companies

H. F. McDONALD
Manager of Sales

ELECTRIFICATION

+ Bell & Zoller Mines

ELECTRICAL practices at the Bell & Zoller group of five mines, producing 20,000 tons per day, reflect the progressive attitude which was responsible for installing 100 per cent mechanical loading at one mine when the number of United States installations could be counted on the fingers of one hand. Over ten years of mobile-loader experience; three mines now fully mechanized; one of the largest bituminous cleaning and screening plants in the world driven by 94 electric motors totaling 2,287 connected-horsepower—these features and the methods followed to maintain high d.c. voltage in working places bespeak advanced electric practices.

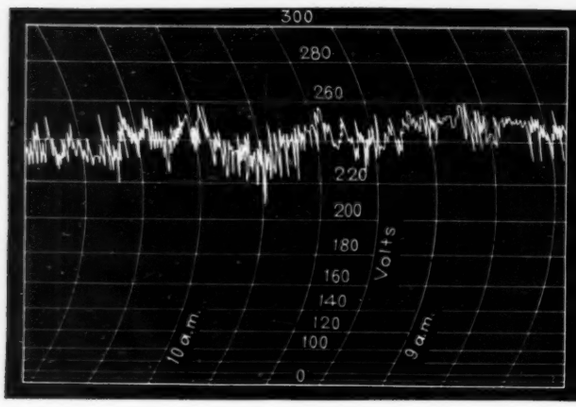
The coal seams mined have but slight general dips and range in thickness from 52 in. to 12 ft. However, 8 ft. is the maximum thickness usually mined. Cover ranges from 0 to 600 ft. One mine, Crescent No. 1, near Peoria, has a drift haulway; Crescent No. 6 has a belt slope; No. 5, at Centralia, has a 544-ft. shaft, and the Zeigler mines, Nos. 1 and 2, have shafts 400 ft. and 300 ft. deep respectively. Excepting low hills over the Crescent property the surface terrain is practically flat. Purchased power is used exclusively at Crescent and partially at Centralia No. 5. Generating plants and steam hoists are operated at Centralia No. 5 and at both Zeigler mines (see power-generation article, p. 109).

No. 1, now producing 6,900 tons in one seven-hour shift, was the first of the two large Zeigler mines to be completely mechanized and so presents the best example of well-regulated d.c. voltage. As in the four other Bell & Zoller mines, its underground machinery operates on 250 volts d.c. Equipment consists of 50 locomotives of five makes, 24 Jeffrey 35-BB mining machines (nineteen working and five spare), eighteen Joy and one Goodman loading machines, including a spare, and 24 Chicago Pneumatic electric coal drills. Haulage-locomotive weights are 13 and 15 tons. Cable-reel locomotives weigh 6 and 8 tons. Six of the gathering locomotives are 5-ton straight storage Manchas with Philco 48-cell 39-plate storage batteries.

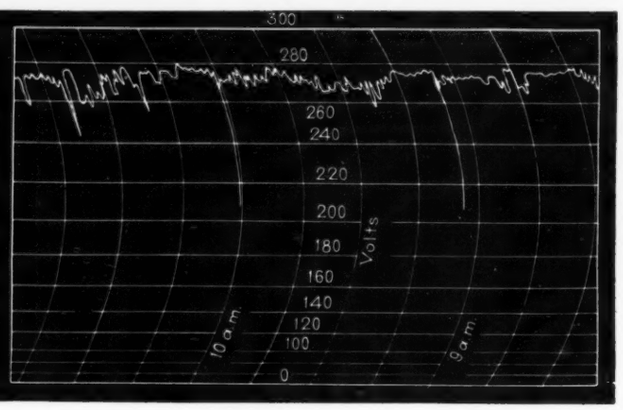
All substations are underground at No. 1 except for one d.c. unit in the power plant at the hoisting shaft. These underground substations, consisting of motor-generators rated at 150 to 300 kw., are of the stationary type and are fed with 2,300 volts through boreholes from a 7½-mile overhead-line system. Instead of lead-sheathed cables, formerly the standard, the latest installations have varnished cambric without lead but with the regulation wire armor.

Because of an arrangement whereby substation operators make bonds, sharpen bits and signals for starting and quitting times (page 139), the motor-generator units are manually started, but automatic reclosing breakers are used in all cases on the d.c. feeder panels. All substations are operated in parallel and there is a connection between every substation in the mine and the main bottom, consisting of a 1,000,000-circ.mil feeder and a 6/0 trolley wire. Each load-machine panel is fed by one 500,-

D.c. voltage during the working shift at the end of the wire serving No. 10 loading machine, 13 West, Zeigler No. 1 mine. The average is 240 volts, which yet is too low to meet the high standard of the mine, so distribution to this section was scheduled for immediate reinforcement



D.c. voltage during the working shift at the end of the wire serving No. 19 loading machine, 8 E. South, Zeigler No. 1 mine. Here the voltage is well above the wire-end standard of 250, thus supplying 230 volts or better to the brushes after deducting cable and wiring drop



000-circ.mil feeder and one 4/0 trolley wire and the feeder is extended to within 500 ft. of the entry face. Each panel also is equipped with an Ohio Brass Co. rib-mounted quick-break knife switch.

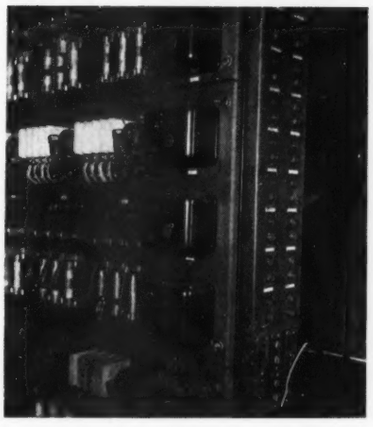
Once every three months a complete survey of the voltage conditions at the ends of the wires in each loading-machine section is made with an Esterline-Angus graphic voltmeter. If at any time a voltage of less than 250 is detected at the end of a wire circuit, feeder size is increased or other steps are taken to reduce the drop. With this value at the end of the stationary wires and a maximum of 20 volts drop in the trailing cables, a voltage of 230 or over is assured at the brushes. Copper-feeder size is determined solely from these voltmeter charts.

Bonding 60-lb. rails to each substation is done with Ohio Brass 9-in. copper arc-weld 300,000-circ.mil bonds, applied two per joint, giving a bond connection of 600,000 circ.mils to the end of affording a conductivity equal to that of the rail. Space for the bonds is made by cutting out the angle bar with a gas torch. Panel bonding consists of one 4/0 copperweld U-bond per rail. A cross bond is applied at each room switch and ahead of each latch. Room bonds are made of two pieces of No. 2 scrap trailing cable in parallel. Steel cable splices are swaged on as terminals and the bonds are applied by steel arc-welding. Substation operators make these bonds.

Unit Power Use Is Low

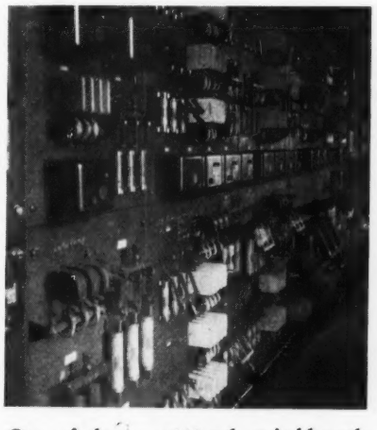
Electric power requirements at the Zeigler No. 1 mine are not high as measured on a unit basis because the hoist is operated by steam, there is no sizing or cleaning plant at the mine and the pumping load is small. Power used during the working shift amounts to 2.52 kw.-hr. per ton and practically all of this is consumed in underground transportation and mining. All the No. 1 output is shipped as run-of-mine two miles to Zeigler No. 2 for preparation (see p. 94) in a central plant serving No. 2 mine on the first shift and No. 1 on the second.

Charging of the locomotive batteries is done on the main bottom using 125-volt power supplied by a Chandeysson 10-kw. balancer set. Ampere-hour meters on the locomotives stop the charging by opening Sangamo switches on the control board. Pumping load in the mine, a small item, consists of five 5-hp., one 10-hp. and one 50-hp. motors, all General Electric. The main fan, normally driven by a 200-hp. wound-rotor 2200-volt motor of the same make, has steam as an emergency drive.



Pushbuttons at the right operate the nine groups of sequence controls and eight individual motor controls in the Zeigler preparation plant. This is a view in the control and switchboard room

Aisle between backs of two 440-volt switchboards which control the 2,287 connected horsepower of motors in the Zeigler preparation plant



One of the two 440-volt switchboards mounting the fuses, relays and magnetic switches for the Zeigler preparation-plant motor circuits

Electric load at Zeigler No. 2 mine took on its present large proportions when loading machines were installed, beginning in August, 1935, followed a few months later by the central preparation plant. Of the 94 motors in that plant, two are 150-hp., two are 125-hp., one is 100-hp. and the rest fall in a range of from 75 to $\frac{1}{8}$ hp. All operate on 440-volt alternating current and generally are of the linestart squirrel-cage type, except that the five largest are wound-rotor units and are started by automatic compensators. General Electric motors, with a few exceptions, are used throughout.

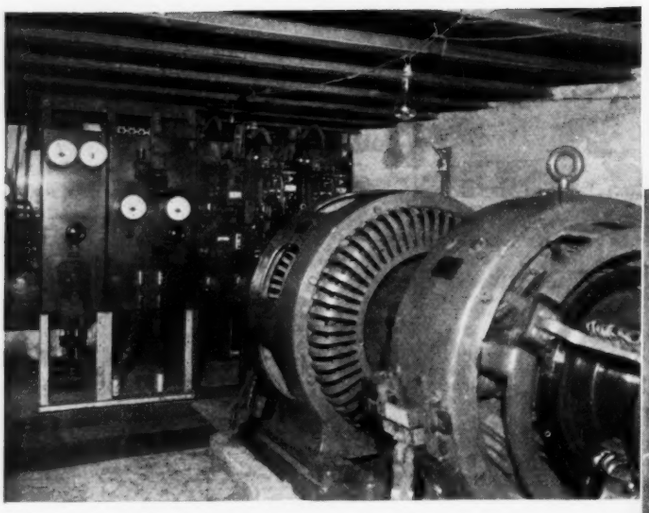
Controls Grouped in Room

All switches and compensators are in a control room which houses the 440-volt buses, fused panels and control buttons. Each motor is protected by three Buss "Super-Lag" renewable fuses and the clips for these fuses, together with magnetic switches (General Electric), are mounted on two panel boards (Post Electric Co.) set back to back. Nine groups of sequence controls handle most of the motors in the plant. Eight motors, however, are separately started and there is an additional sequence for conveyor equipment taking coal to the adjacent power plant. The control-room operator starts and stops all equipment in compliance with bell signals.

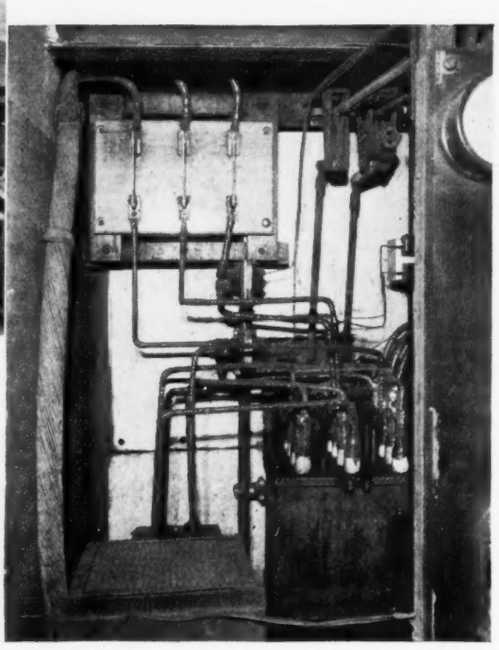
Transformer capacity (1,998 kva.) for operating the preparation plant is supplied by a group of six 333-kva. 2,400/480-volt Westinghouse Type S.L. oil-insulated units mounted on a high platform outside but adjoining the building. These transformers are arranged in two banks, with each bank separately feeding one control panel.

Special electrical equipment in the plant includes two Stearns magnetic pulleys, five Syntron controllers for the same number of electric vibrating screens, and two Westinghouse 400-watt high-intensity mercury lamps mounted over the lump picking table. General lighting is provided by 200-watt Mazda lamps in dust-tight globes. Drive connections from motors to major equipment include 41 Gates V-belt, 26 Jones reducers, and two General Electric gearmotors.

General Electric disk brakes are used on several of the conveyor motors and two Thrustor brakes (300 lb. 3-in. movement, 3 hp. 440 volts) are

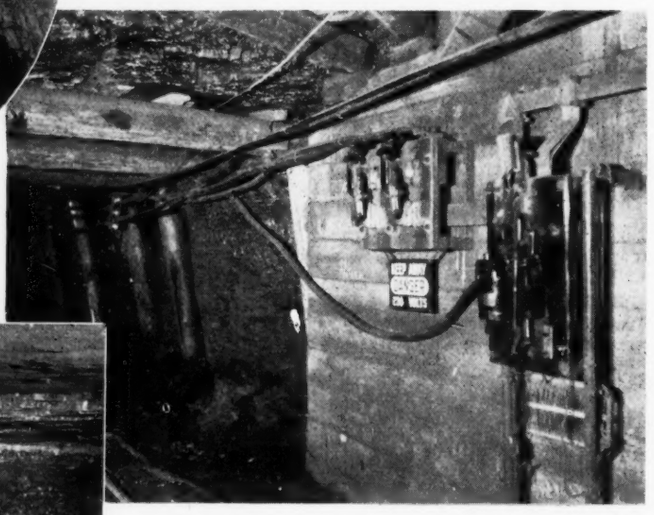


This room with steel ceiling and a 300-kw. motor generator with three reclosing breakers in this substation at First Northwest, No. 2 mine, is typical of Zeigler underground substation practice.

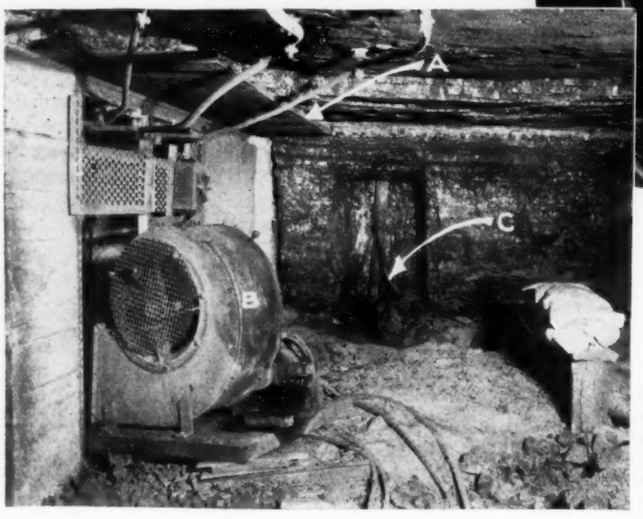


Borehole cable terminated at disconnect switches in a Zeigler No. 2 mine substation.

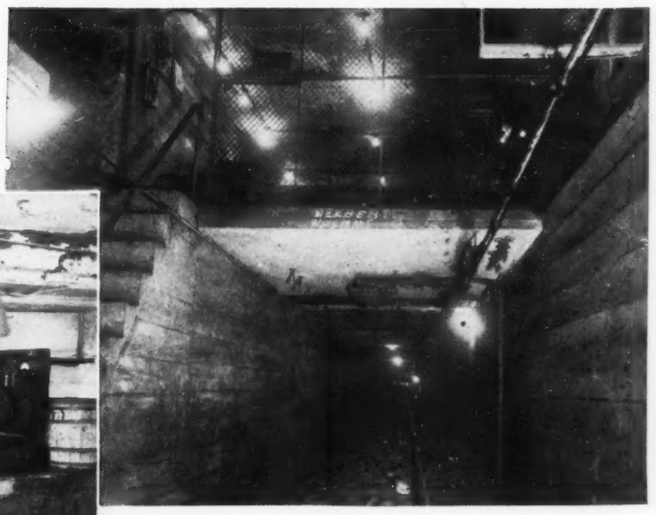
A 4/0 trolley wire and a 1,000,000-circ.mil feeder on combination clamps and, closer to the rib, a second 1,000,000-cir.mil feeder on 13th East, First Northwest, Zeigler No. 2 mine.



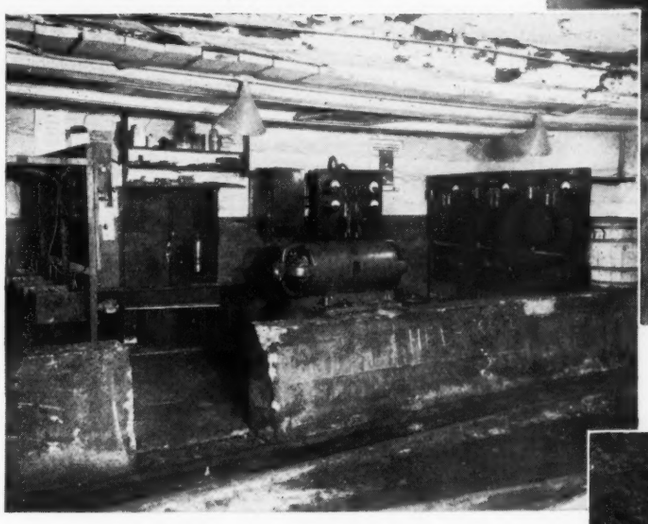
Two 1,600-amp. switches on the left assure trouble-free switch connection between the top motor-generator and the main-bottom d.c. bus, Zeigler No. 2 mine.



Outside f the back wall (intake air end) of a 300-kw. substation in Zeigler No. 2 mine. "A" indicates the ends of 8-in. car channels which form the steel roof, "B" is the blower and "C" the armored 2,300-volt cable at the bottom of the borehole.



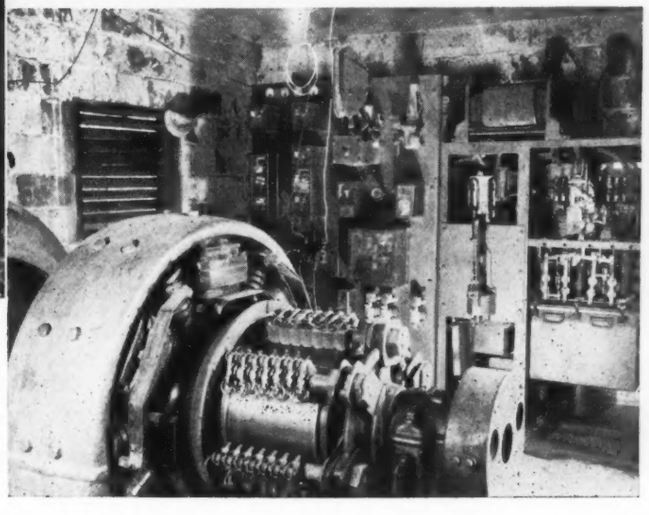
On Main East at 5th Southeast, Zeigler No. 2 mine, a 300-kw. substation is installed in a high place above the haulage track.



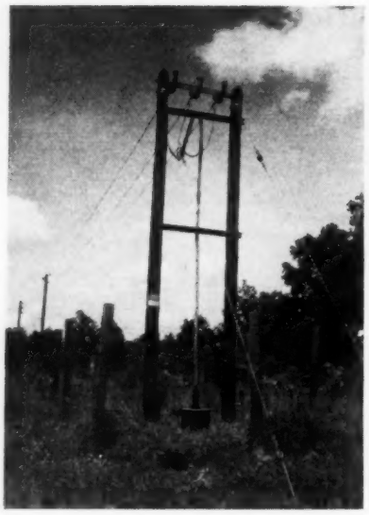
Battery locomotives at Zeigler No. 1 mine are charged on the main bottom by this balancer set.

At Centralia No. 5 mine three 1,000,000-circ.mil positive leads from the d.c. power plant feed this distributing panel at the bottom of the shaft. The trolley wire extending across the center of the picture is 6/0.

Two 1,000,000-circ.mil feeders and a 6/0 trolley wire make up the positive line on Main East at 9th Southeast, Zeigler No. 2 mine.



This 200-kw. full automatic outside substation at Crescent No. 6 mine is started and stopped from a push-button station on the main haulway near the bottom of the borehole.



In contrast to the former practice of 2,300-volt underground cable distribution, pole lines and boreholes are now preferred at the Zeigler mines. Note the use of cable drip loop instead of a pothead.

This borehole cable support at No. 2 is typical of the Zeigler practice of using wire-armored cables and standard clamps. The shell of an oil drum was used as the form for the concrete foundation.

used on the motor shaft and its extension operating the two hoists of a Mead-Morrison railroad-car dumper handling run-of-mine coal from No. 1. The 100-hp. wound-rotor motor of this dump and its magnetic controller also are General Electric. The drive connection is a Jones herringbone speed reducer.

Principal underground electrical equipment in Zeigler No. *2* consists of the following: main haulage locomotives—six 13-ton Jeffrey, one 12-ton Goodman; relay locomotives—seven 8-ton Jeffrey; push locomotive on bottom—one Jeffrey 10-ton slow-speed (500-volt); service or gathering locomotives (all Jeffrey)—fourteen 6-ton MH88J, seventeen 8-ton MH100; material-handling locomotive, shaft bottom—one 6-ton Jeffrey MH88; mining machines (all Jeffrey)—fourteen 35BB, 50-hp., 8½-ft. cutter bar; twelve 35B, 35-hp., 7½-ft. bar; loading machines—ten Joy 11BU and seven Joy 5BU (one a spare). Four of the Jeffrey 8-ton locomotives are slow-speed units (4 m.p.h.); these are used both in service and relay hauls.

Other underground electrical load includes 23 Chicago Pneumatic No. 474 coal drills, one Airdox compressor driven by three motors (one 50-, one 7½- and one 3-hp.) and eight pump motors. The latter range from 3 to 10 hp. and all but three are d.c.

Direct current at No. *2* is supplied by stationary underground substations except for one 300-kw. motor-generator and one 300-kw. engine-driven generator in the power plant at the hoisting shaft. The latter generator, however, is not used regularly. The underground capacity of 1,400 kw. consists of four 300-kw. and one of 200-kw. substations. All have manual controls except that between bus and feeders automatic reclosing breakers are used. Two substations have Westinghouse motor-generators, two have General Electric and one has a Ridgway. All of the automatic d.c. breakers were made by the Automatic Reclosing Circuit Breaker Co. or its successor, the I-T-E Circuit Breaker Co. Sizes and types are as follows: eleven 1,000-amp. Type KSA; two 1,000-amp. Type DHDX and four 600-amp. Type KSA.

Substation Built Overhead

An unusual type of construction adopted for one of the underground substations consists of a concrete platform, or bridge, spanning the haulage track on the Main East at 5th Southeast. At this point, headroom created by grading the haulway was available and its use for a second-story substation saved excavation and simplified ventilation of the equipment.

Other substations in the mine are placed in excavated rooms having concrete walls and steel ceilings. Auxiliary ventilation is used if loads are heavy. The ceiling lagging, consisting of 8-in. channels from old mine cars, is set on joists of 90-lb. rails. A blower is mounted next to a hole in the back wall and several sacks of rock dust for fire use are kept outside of the room on the intake air.

Regular d.c. circuit construction on all haulage roads is based on one No. 6/0 trolley wire in parallel with one 1,000,000-circ.mil bare feeder cable, both carried by Ohio Brass combination trolley and feeder clamps. The return consists of 50- or 60-lb. track with each joint bonded with one 4/0 and one 400,000-circ.mil bond

Sequence Starting Arrangement for the Principal Motors in the Central Preparation Plant at Zeigler No. 2 Mine

Motor		Equipment Driven	
Number	Horsepower	Number	Name
			System A
2	10	3-B	Screen
3	10	3-A	Screen
3-A	10	3-C	Screen
4	20		Conveyor D, No. 1 crusher
5	20		Picking table, No. 2 grizzly
6	150		Conveyor A, Grizzly No. 1
7	15	1	Duplex feeder
8	25		Belt conveyor B, Feeder No. 2
			System B
9	7½	G	Boom conveyor
10	5	C	Belt conveyor
			System C
11	30	2	Shaking distributor
12	10	5-B	Screen
13	15	5-A	Screen
13-A	20	F	Belt conveyor
			System D
16	20	3	Shaking distributor
			System E
19	7½	T	Elevator
20	7½	S	Conveyor
21	7½	R	Conveyor
			System F
1	40	E	Conveyor
67	25		Dust screw system
68	5		Buckwheat (raw carbon) feeder
66	40	GD	Elevator
			System G
63	5	Y	Dust screw
26	75	2	Rotoclone
27	75	3	Rotoclone
28	75	1	Blower
30	10	1	Airflow box, north end
27	75	1	Rotoclone
29	75	2	Blower
31	10	2	Airflow box, south end
			Stoker system
63	150	4	Crusher
64	5	O4	Conveyor
22	15	J	Conveyor Boom
			Washing and sizing sequence
14	10	4-B	Screen
15	10	4-A	Screen
17	10	6-B	Screen
18	10	6-A	Screen
32	30	H & I	Boom conveyors
33	30	K & L	Boom conveyors
34	50	M & N	Boom conveyors
35	7½	G	Hoist boom conveyor
36	7½	H	Hoist boom conveyor
37	3	I	Hoist boom conveyor
38	3	J	Hoist boom conveyor
39	3	K	Hoist boom conveyor
40	3	L	Hoist boom conveyor
41	3	M	Hoist boom conveyor
42	7½	N	Hoist boom conveyor
43	50		Conveyors O1, O2, and O3
44	10	P	Elevator
45	10	Q & X	Conveyors
46	5	W	Conveyor
47	10	7	Screen
48	10	8	Screen
49	3	9	Screen
50	5	10	Screen
51	75		Crusher No. 3 and belt feeder motor No. 61
			Following items each started separately
52	40		13½-ft. cone agitator
53	50		16½-ft. cone agitator
54	125		5,000-g.p.m. pump
55	75		2,000-g.p.m. pump
56	125		5,000-g.p.m. pump
57	30		1,500-g.p.m. pump
58	25		1,000-g.p.m. pump
59	20		Box-car loader

(mostly Electric Railway Improvement Co.).

Copper return is used only where a second 1,000,000-circ.mil positive feeder must be added, in which case a 1,000,000-circ.mil negative, laid on the bottom near the rib, is connected in parallel with the track. For panel work a 1,000,000-circ.mil feeder is carried to the point of split and then one 500,000-circ.mil feeder used down each panel entry. Both rails in panel tracks are bonded. Until recently, when 300,000-circ.mil copper-arc-weld U-bonds were adopted, the standard in panels was one 4/0 28-in. bond per joint.

Room trolley wires, size 4/0, are extended to the last car-changing point. Over this distance, one rail of the track is bonded with steel arc-weld bonds made as described above.

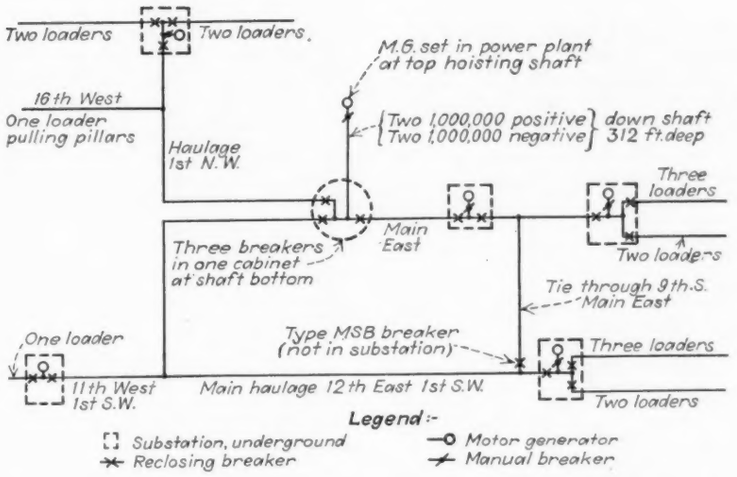
All substations are fed by 2,300-volt cables and in all but one case these cables enter through boreholes 275 to 334 ft. deep. Standard 3-conductor wire-armored borehole cable without lead sheathing is used and is suspended by a standard split-sleeve clamp. The remaining substation is fed by a cable entering via the air shaft and extending 4,600 ft. along the aircourse. This cable has a lead sheath and wire armor. It is buried in a shallow trench in the fireclay bottom and the junctions are made in "Standard Underground" steel splice boxes filled with Ozite.

Prior to the change to mechanical loading, a.c. cables carried underground were the standard practice, but now the overhead line and borehole are preferred because they are considered more economical. At present a total of 31,000 ft. of 2,300-volt pole line is in use carrying power to boreholes at No. 2 mine. The farthest borehole, which is 10,500 ft. air line from the main shaft and power plant, is fed by a pole line 12,800 ft. long. Creosoted long-leaf yellow-pine poles, 35 ft. long, spaced 125 ft. and set 5½ ft. in the ground, are used and the No. 3/0 and 4/0 solid copper conductors are carried on Ohio Brass insulators supported by steel bow-arrow arms providing a 24-in. wire spacing.

At boreholes, the lines terminate at two 30-ft. poles 7½ ft. apart and connected by one ½x3x3-in. galvanized angle across the top for attachment of strain insulators and by two ¼x3x3-in. angles, one 2 ft. from the top and the other 12 ft. from the ground. To these ¼-in. angles the cable extending out of the borehole is attached so as to form a drip loop at the top. Weight of the cable is carried by a split clamp which rests on a concrete foundation at the top of the borehole. Drip-loop cable terminals are preferred because some trouble was experienced with potheads. Lightning protection is provided by General Electric pellet-type oxide-film arresters. Ohio Brass strain insulators are used.

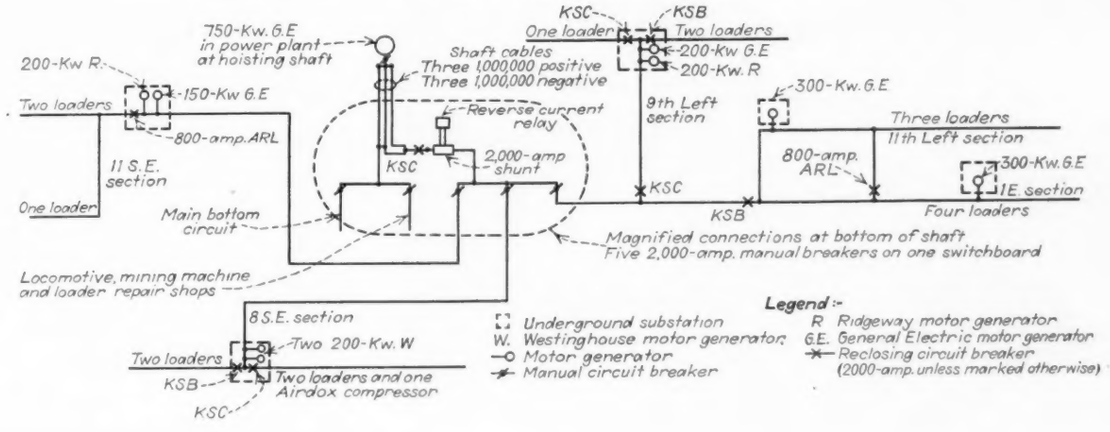
Turning again to the underground electrical equipment, five "electric switchmen" made by the Mines Equipment Co. and equipped with amber and green lights are in use. Tracks are equipped with block signals using red and blue lights. Both the electric switch throwers and signals are manually operated from pendant switches. The longest signal line in use extends more than 8,000 ft. and consists of a 3-conductor No. 12 parkway cable with metallic ribbon armor. Most of the signal lines, however, are No. 14 single-conductor rubber-covered double-braided wire.

Both Western Electric and Stromberg-Carlson special mine-type tele-



Schematic diagram of d.c. system, Zeigler No. 2 mine. In addition to the equipment shown on the diagram, sufficient 1,500-amp. knife switches are installed so that 2,400-ft. lengths of the circuit can be isolated.

Schematic diagram of d.c. system in Zeigler No. 1 mine, the first to be completely mechanized. The 11 S.E. and 1 E. sections are each approximately 2 miles from the shaft. Positive conductors of the three principal circuits from shaft to substations consist of a No. 6/0 trolley wire and a 1,000,000-circ.mil cable.



phones are used underground and the connecting circuits are Tirex two-conductor portable cord, No. 14 and No. 16 sizes. This cord is purchased in 1,000-ft. lengths and the splices are insulated with rubber tape. For the most part this cord is fastened to the roof but in some places is carried on the ribs. From each parting to the loading-machine section there is maintained a separate line, and it is not possible for the loading section to call the shaft bottom.

Haulways Are Lighted

Mine lighting consists of 200-watt 275-volt lamps on the bottom and 100-watt 275-volt lamps on the haulways, both without reflectors. The latter are spaced 120 ft., in contrast to an earlier practice of using 200-watt lamps spaced 250 ft. The latter, however, had the disadvantage of producing an effect of light and dark spots so that the rails were not visible for as long a distance as with the smaller lamps and closer spacing.

The fan at Zeigler No. 2 regularly is driven by a 200-hp. 2,300-volt motor with an auxiliary steam engine. Between the generating plants at the two mines is a pole-line tie; it is used only in emergencies, however, as the two mines, although only two miles apart, ordinarily are operated with the electrical systems separated.

No. 5 mine of the Centralia Coal Co., producing 1,900 tons per day with six active Joy 5BU loading machines, has the distinction of having been one of the first 100-per-cent mechanical mines to be so converted at one stroke, this on Nov. 1, 1927 (*Coal Age*, May, 1928, p. 288). Except for the electric power purchased at 2,300 volts for one 300-kw. Allis-Chalmers m.g. substation 1½ miles from the mine topworks, the mine equipment, including tipple motors, pumps and the fan, is driven by d.c. generated in a power plant also supplying steam for the hoisting engine.

In the substation borehole, which is 550 ft. deep and was installed in 1930, an American Steel & Wire cable of the following specifications was installed: three-conductor, No. 4/0, special borehole cable, rubber covered, without lead sheath but protected by wire armor. The substation a.c. control is manual but the d.c. side has an automatic reclosing breaker. Two other automatic d.c. breakers are used on the mine-haulage circuit. Measured by electrical circuit distance the substation is 2¼ miles from the shaft bottom. Two reclosing circuit breakers are used on the haulage circuits.

Positive lines consist for the most part of No. 4 Fig. 8 trolley wire in parallel with 1,000,000- and 500,000-circ.mil feeders, some bare and some insulated. Beginning recently, however, the 4/0 trolley wire on haulways is being replaced by 6/0. For all three duties, main lines, panel entries and rooms, the rail-circuit conductivity is assured by Ohio Brass No. 4/0 steel-rod arc-weld bonds.

Prinicipal items in underground load are: nineteen locomotives, of which thirteen are actually in use during the day, or loading, shift; six Goodman 112AA universal 8½-ft.-bar shortwall machines; six Chicago Pneumatic No. 472 electric coal drills; and seven Joy loading machines (one spare). In detail, the locomotive equipment consists of: main haulage—two Westinghouse 15-ton; relay (all General Electric)—three 6-ton with 8-ton equipment; two 6-ton cable-reel; gathering or service (all 6-ton Goodman single-motor cable-reel)—seven 2600K, one 2600R and four 2600S.

Braid-covered trailing cables are used on both locomotives (No. 3 single) and mining machines (two-conductor concentric). Tirex No. 4-size rubber-sheathed cable is used on the Joy loaders and the same make in a No. 12 size on electric coal drills.

The mine fan, a Jeffrey 7-ft. Aerovane unit at the foot of the air shaft, is driven by a 40-hp. General Electric d.c. motor with automatic starter. The one pump in the mine, situated at the foot of the main shaft, has a 15-hp. d.c. motor and automatic control of the same make. Eleven d.c. motors, the largest a 125-hp. unit driving a crusher, make up a total connected tipple horsepower of 190.

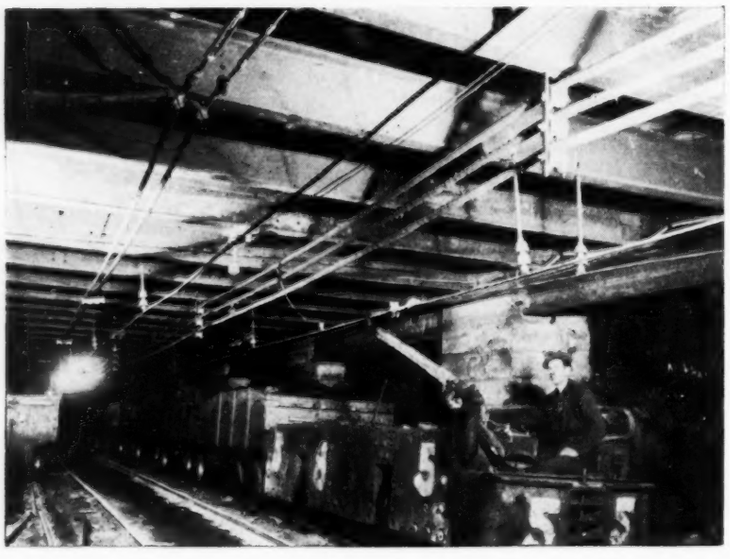
Crescent Purchases Power

At Crescent No. 1 and No. 6 mines of the Crescent Mining Co., near Peoria, all of the electric power is purchased and its utilization and distribution differ somewhat from that at the Zeigler and Centralia mines because the Crescent operations have a varying, though shallow on the average, depth of cover. No. 1 mine has a light-pitch slope opening and No. 6 a belt slope 440 ft. long on an 18-deg. pitch. At No. 6 the production of 3,400 tons per day is hand loaded while the production of 2,225 tons at No. 1 is 75 per cent by hand loading and 25 per cent by mobile loaders. Lower coal (52 in.), meaning longer hauls and more substations for the tonnage involved, and the use of a large number of electric pumps are in contrast to Zeigler and Centralia conditions.

Both shortwall and breast-type cutting machines are used in the Crescent mines, 18 in No. 1 and 28 in No. 6. Locomotive sizes range from 6 to 15 tons, there being five in use in No. 1 and six in No. 6. No cable-reel units are used because the gathering is done with mules. Loading machines at No. 1 mine consist of one Joy 8BU, one Jeffrey 44DD and another Jeffrey 44EE.

Both full-automatic and manual substations are used; all contain but one unit and are underground, with the exception of two at No. 1 mine which are placed on the surface because of wet conditions underground. All units are motor-generator sets and in each case the feeders leaving the substations are equipped with

In the upper right in this view on Zeigler No. 1 main bottom appear the three 1,000,000-circ.mil d.c. cables which are the tie between the underground substations and the 750-kw. motor-generator in the power plant.



Columbus (I-T-E) reclosing circuit breakers. Loads of substations in several instances are confined to cutting machines only.

The list of substations and control (abbreviating General Electric by G.E., Westinghouse by W. and Ridgway by R.) is as follows: No. 6 mine—200-kw. R. manual, 150-kw. W. with G.E. automatic control, 200-kw. G.E. with G.E. automatic control, 150-kw. G.E. manual, 200-kw. R. manual; No. 1 mine—150-kw. G.E. manual (on surface), 200-kw. G.E. with G.E. automatic control (on surface), 200-kw. G.E. with G.E. automatic control and 150-kw. W. manual. In No. 6 mine two of the substations are operated in parallel and the others run independently. In No. 1 mine the three General Electric substations operate in parallel and the Westinghouse is operated with an independent circuit. The 200-kw. full-automatic General Electric surface substation at No. 1 mine is started and stopped from a pushbutton station on the main entry about 250 ft. from the bottom of the substation borehole.

Underground substations are fed at 2,300 volts by rubber-insulated wire-armored borehole cables, some having a lead sheath and others without lead. Nine pumps in the two mines operate from 440 volts a.c. and these circuits enter via borehole cables of the same types as used on the 2,300-volt lines.

Besides the nine a.c. pumps, the largest of which is driven by a 15-hp. motor, the two mines contain fifteen smaller-sized d.c. pumps, mostly of the reciprocating type. These, however, are being replaced by centrifugals with 440-volt a.c. motors. Five fans driven by 5- and 10-hp. 440-volt motors ventilate the two mines. In every case the motor-to-fan connection is a Tex-rope V-belt drive.

Two 6/0 trolley wires, mounted one above the other, constitute the positive conductor in d.c. distribution along most of the mains. On the short-life entries one 4/0 trolley wire serves in most cases. Rail weights are 60-lb. on mains, 40-lb. on cross or short-life entries and 16-lb. in panels and rooms. The 16-lb. tracks are not bonded but Ohio Brass 4/0 steel arc-weld bonds are the standard for 60-lb. and 40-lb. tracks.

The Crescent mines have now been under Bell & Zoller operation for seven years and all during that time electrical modernization has been going forward. In contrast to the Centralia and Zeigler mines, particularly the latter, the motor units at the Crescent mines are smaller but more numerous and widely scattered for the tonnage involved.

POWER GENERATION

+ Bell & Zoller Mines

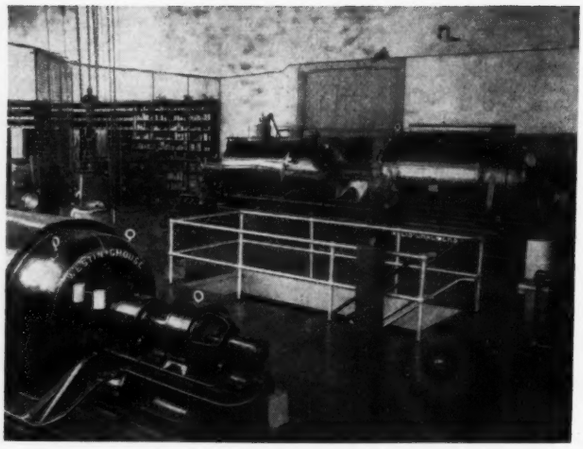
ELECTRIC POWER is generated at three of the five Bell & Zoller mines and in each case a coal hoist and a man-and-material hoist are operated from steam generated in the common boiler rooms. Total generator capacity of the three plants is 12,050 kva. and at one mine, Zeigler No. 1, where one generating unit is a mixed-pressure turbine, exhaust steam from the skip hoist is utilized for making electric power. Two of the three plants are at the Zeigler mines and, although these plants are but two miles apart and there is a transmission line between for emergency transfer of power, they are operated independently, except in starting up one station, because it is felt that the management of the two mines is more effective when there is a complete separation. Centralia No. 5, the other mine at which power is generated, is 60 miles northwest of the Zeigler properties.

Zeigler No. 1 coal, to the tune of 6,900 tons per day, is raised 460 ft. in 10-ton skips operated by a 28x42-in. 6- to 9-ft. stepped cylindrical drum hoist. This hoisting engine is in one end of the power-plant engine room. Other equipment in that room consists of: one 750-kva. 2,300-volt mixed-pressure turbo-generator with Manistee roto-type jet condenser, one 2,500-kva. 2,300-volt high-pressure (150 lb.) turbo-generator with Elliott jet condenser, one Chuse-General Electric 300-kw. 250-volt d.c. unit, one Hamilton-Western Electric 500-kw. 250-volt unit, and one 750-kw. General Electric motor-generator set.

Steam-raising equipment consists of four 412-hp. Heine water-tube boilers with furnaces equipped with Greene chain-grate stokers and Greene suspended arches. Ashes are carried to an elevated bin by a United Conveyor Corporation steam jet conveyor. Feed water is secured from a filter plant at the mine, which conditions water from the Big Muddy River (1½ miles away) for the town of Zeigler. As the water is fed to the boilers it is treated with phosphate and soda. Fuel supplied to the plant is principally 1-in. dedusted screenings, but some washed coal of that size also is used. Three thousand tons per full-time month is the normal consumption. Approximately 5 kw.-hr. of electric power is generated for each ton of coal hoisted from the mine.

Exhaust steam at a pressure of 5 to 6 lb. from the skip hoist passes to a heat-insulated accumulator outside of the building. When the hoist has stopped long enough to cause the boiler pressure to rise, high-pressure steam automatically is admitted to the mixed-pressure turbine to supplant the exhaust steam. Condenser circulating water, together with the water of the condensed steam, is cooled in a spray pond. The boiler plant also furnishes steam for two auxiliary

Generating capacity of the Zeigler No. 2 power plant was increased when the 1,000-tons-per-hour control preparation plant was built at the mine.



Zeigler No. 2 has two turbo-generators: 1,875-kva. (foreground) and 4,000-kva. (background). The engine-driven units (not shown) are at the right.

hoists, one of which handles men in a compartment of the main skip shaft and another of which handles men and supplies at the auxiliary shaft.

Power-plant operating men and hoisting engineers are supervised by the top foreman. Twenty-one men, including extras, make up the total force of firemen, engine-room attendants, boiler repairmen and hoisting engineers. On the Big Muddy River the company maintains a pumping plant containing two 350-g.p.m. Manistee centrifugal pumps driven by 25-hp. 440-volt motors.

Generating Capacity Raised

Because of the additional load imposed by a new central cleaning plant with motors totaling 2,287 connected-horsepower, the Zeigler No. 2 power plant, built in 1919, was increased in capacity in November, 1935, by the addition of a 4,000-kva. 2,300-volt 3,600-r.p.m. Allis-Chalmers turbo-generator with Allis-Chalmers jet condenser. Aside from this unit, generating equipment consists of: one Westinghouse 1,875-kva. 3,600-r.p.m. turbo-generator with Manistee roto-type jet condenser, one direct-connected Chuse-General Electric 675-kva. 2,300-volt unit, one direct-connected Chuse-General Electric 300-kw. 250-volt d.c. unit, and one Westinghouse 300-kw. motor generator.

Six Heine 365-hp. straight-tube water-tube boilers with furnaces equipped with Greene chain-grate stokers furnish steam for the electric generators, the coal hoist and, in winter, for heating the 1,000-tons-per-hour central preparation plant adjoining the power house. Feed water is heated by exhaust steam from the 300-kw. d.c. unit and from turbine-driven centrifugal boiler feed pumps, but in addition the 4,000-kva. turbine is equipped with a bleed-off heater. Dimensions of the power house building, which includes the boiler room, engine room and space on the engine-room floor allotted to a central warehouse, are 100x164 ft.

Boilers carry a 160-lb. pressure and have Copes feed-water regulators. Dampers and stoker speeds are regulated by a Defender automatic regulator. Four of the boilers have Greene flat arches, one has a Dietrick arch and the sixth a Greene high arch similar to the Dietrick. All boilers are equipped with Vulcan soot blowers. Elevating coal to the bunkers (40-ton bunker per boiler) and conveying and elevating ash to the disposal bin is accomplished with a Link-Belt peck carrier, in which type the buckets are pivoted and always are upright. A brick stack 12 ft. in outside diameter at the top and 225 ft. high furnishes natural draft.

The main hoist, a Litchfield 28x42-in. unit with 8-ft. cylindrical drums, is operated at extremely high duty and creates a high demand on the boiler plant. Cars are hoisted 345 ft. and the tonnage handled in 7 hours runs as high as 5,900. At the start the engineer jerks the throttle wide open for 7 seconds. He then takes 5 seconds to check the speed and put the car into the dump. Caging takes 3 seconds. On this basis, four cars are hoisted per minute. At the time the throttle is shut off the engines are making 131 r.p.m. and the rope speed is 3,292 ft. per minute.

Operation of the power plant is under the supervision of the master mechanic, who also is the top foreman, and the force consists of four firemen, four operating engineers, three boiler repairmen and two coal and ash handlers. All work five 7-hour days, except firemen and operating engineers, five 8-hour days each. Four hoisting engineers complete the power force.

Table I—Coal Hoisted and Used as Boiler Fuel, Zeigler Mines, First Half of 1937

	Mine No. 1		Mine No. 2	
	Tons Hoisted	Tons Fuel*	Tons Hoisted	Tons Fuel†
January	121,569	2,935	114,797	2,632
February	136,107	3,166	128,627	2,797
March	195,242	3,252	149,084	3,296
April	(Idle)	104	77,500	2,101
May	60,533	2,026	42,578	1,756
June	68,077	2,112	38,029	1,915

* Mostly 1-in. dedusted screenings, some washed. † Mostly 1½-in. dedusted screenings, unwashed.

Feed Water Treated

Condenser water is cooled in a spray pond. Boiler-feed water is taken from a pond filled by natural drainage and this water is treated by pumping individually into each boiler a concentrated solution of phosphate and soda ash. "Shots" of 3 gal. of the solution are injected every hour during the day and every two hours during the night. Boilers are equipped with continuous blow-downs with micrometer-flow valves. This blow-down is taken off about 6 in. under the low-water level, which is the point of maximum concentration.

Fuel used in the Zeigler No. 2 plant is principally 1½-in. dedusted unwashed screenings. This coal can be conveyed directly from the preparation plant or can be brought in in railroad cars, from which the coal

can be passed over the main belt conveyor to the preparation plant and then diverted to the power-plant conveyor.

At Centralia No. 5 mine, although it was opened in 1908 and is today producing 1,900 tons per day, the original 250-volt d.c. power plant and steam hoist are performing without any drag on production. Purchased power, however, is used for the most distant workings. It was in 1930, three years after mechanical loaders were installed, that the increased load and excessive distance called for a change, and as a remedy a 300-kw. underground substation supplied with purchased power was installed 2¼ miles by mine circuit from the shaft bottom.

The power-plant load during the working shift is approximately 550 kw. Available generating capacity is made up of the following units: Chuse-Sprague, direct-connected, 300 kw.; Ridgway-Goodman, belt-driven, 200 kw.; Skinner-Sprague, direct-connected, 50 kw.; Ridgway-Ridgway, direct-connected, 200 kw. Steam for power uses is generated in five John O'Brien 150-hp. 120-lb. pressure horizontal-return-tubular boilers equipped with hand-fired furnaces with shaking grates. Another boiler of the same type, but limited to a 100-lb. pressure, is used for heating during the winter months. Fuel is a bar-screen 2½x0-in. product taken out of mine-run.

Generators Run Non-Condensing

All generating units are non-condensing but exhaust through an oil separator to an open-type horizontal-round-tank feed-water heater. The duty of the hoisting engine, a Danville 24x42-in. unit with 10-ft. cylindrical drum, is raising cars a total distance of 600 ft. The record is 1,107 dumps in eight hours.

Crescent Nos. 1 and 6 mines, near Peoria, are served by drift and belt-slopes, respectively. All power is purchased. Bell & Zoller thus generates high-pressure steam only where hoists are used, in which cases steam generation for hoisting is combined with an electric power plant.

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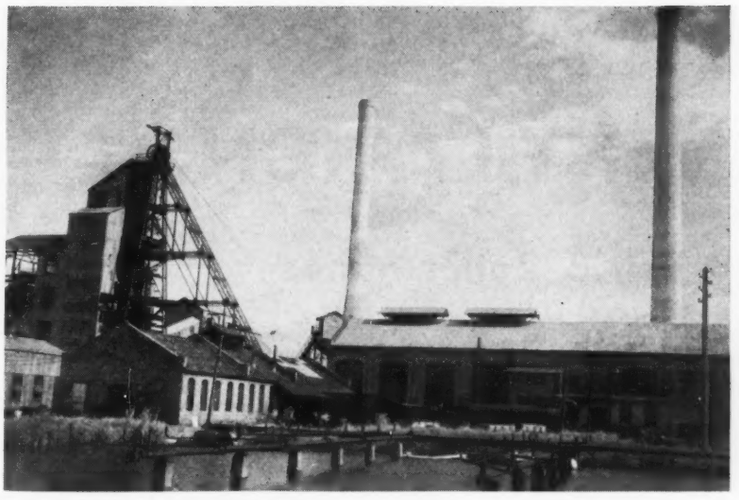
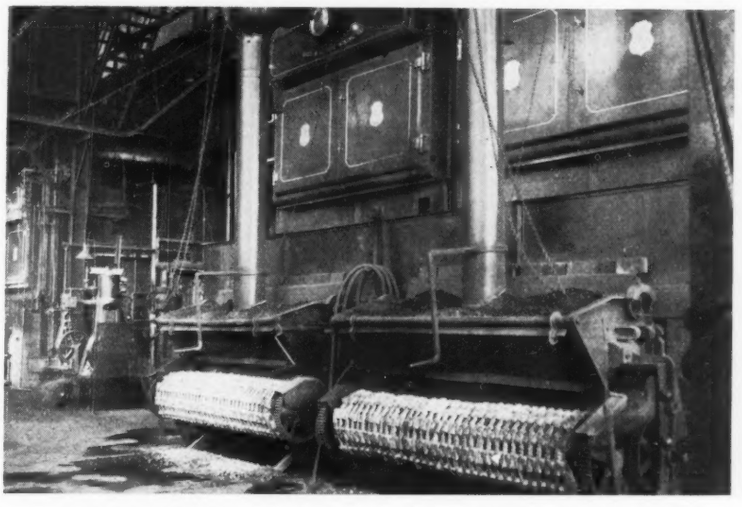


Looking over the spray pond toward Zeigler No. 1 topworks and power plant. This photograph was made while the mine was idle for revisions in dumping arrangements



At Zeigler No. 2, steam is generated by chain-grate stokers and water-tube boilers

Water for the Zeigler No. 1 power plant comes from this pumping station on the Big Muddy River

VENTILATION

+ Bell & Zoller Mines

VENTILATION at the five Bell & Zoller mines presents a variety of methods and equipment to meet the different conditions encountered in operations ranging from deep, gassy, thick-seam, large-tonnage full-mechanical mines to a non-gassy, medium- to thin-seam, hand-loading drift mine producing 2,250 tons. Recent betterments at one mine reduced fan power to approximately one-third the former value and an improvement program of several years' standing at another mine has increased the ventilation efficiency from 15 to 45 per cent.

At the Zeigler Nos. 1 and 2 mines, producing respectively 6,900 tons and 5,900 tons per day with mobile loaders (single-shaft), the seam is 8 to 12 ft. thick, of which 7½ to 8 ft. is mined. Methane emission is indicated by 0.3 percentage in the main return when the No. 1 fan is circulating 190,000 c.f.m. through the mine. The ventilating systems at these two mines are similar even to the fans, one at each mine. These are Jeffrey 5x16-ft. centrifugals with auxiliary drives.

At both Zeigler mines, the air shafts, where the fans are installed, are within 800 ft. of the hoisting shafts. No auxiliary air shafts have been sunk. As indicated in the accompanying tabulation of ventilation data, longest air travel is over six miles.

The coal is mined by panels, and room pillars of sufficient size are left to prevent roof breaks to the surface. But two entries (four headings) connect a panel to the adjoining entries and as soon as a panel is completed and the adjacent panel also completed, the two headings of the first panel are sealed permanently with concrete. To make it unnecessary to use doors except at the head of the main and cross entries, off which panel entries are driven, the "aircourse-room" system (Fig. 1) has been adopted.

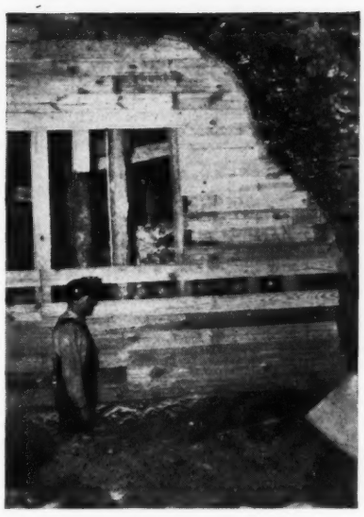
As driven ahead of panel development a main or cross entry has but two headings. Two rooms from one panel entry are holed through to the next panel entry and a solid pillar is left between this pair of rooms and the first working room. A series of pairs of aircourse rooms forms the equivalent of two additional headings.

Three general types of stoppings are used in the Zeigler mines: viz., monolithic concrete to seal completed panels, monolithic concrete or concrete blocks as permanent stoppings on main entries, and brattices on panel headings for temporary control of ventilation currents. The panel seals, not less than 18 in. thick, are built of a 1-2-4 mixture of cement, sand and limestone, using wood forms. Suitable mine rock, if available, usually is put into the center of the wall and the concrete is slushed all around. To prepare for the seal the ribs are notched back to solid coal and the floor is excavated 1 to 2½ ft. down through the fireclay to hard shale. The 3 to 4 in. of concrete against the roof, which cannot be poured, is applied by tamping in a damp sand and cement mixture of a consistency which will just ball up in the hand.

Holding the roof coal in place on each side of the seal is considered of major importance. This is done by setting zinc-chloride-treated posts and headers on both sides of the seal. The roof coal is not trenched for the seal because it has been found best not to weaken it, since it is a far better top than can be found for many feet above.

Permanent stoppings on main headings are built in much the same fashion as the panel seals but are not so thick. Only in the last two years have concrete blocks (mostly cinder-concrete) been used to some extent for the permanent stoppings. Temporary brattices on panel headings are built of Burkett lath covered with a ½- to ¾-in. coating of ordinary wood-fiber plaster. This lath, which is laid tight without open cracks between, consists of boards with dovetail grooves rabbeted into one face.

Worked-out panels at Zeigler are sealed by 18-in. concrete walls, with the top coal on both sides supported by treated posts and headers, as in this view in First North off Second East, Ninth Southeast, No. 2 mine.



Panel seal under construction, Fourth North off Second East, Ninth Southeast, Zeigler No. 2 mine. The back form for the wall is about completed.

Since both mines load mechanically and as the number of men working underground is small compared to the tonnage and working area, the air inputs to dilute the methane to a safe value are far above State law requirements of not less than 100 c.f.m. per man. Whenever, in any split or in a main return, a methane content of 0.5 per cent or above is revealed by a regular sampling and analysis, action immediately is taken to increase circulation. Usually cleaning airways is an effective remedy. All seals blocking off worked-out panels are inspected each day the mines work.

Overcasts, six in No. 1 mine and three in No. 2, are concrete-and-steel fireproof construction. Approaches are rock-filled to reduce turbulence. Steel roof supports are used over the overcasts in both mines and in No. 1 mine the entire roofs, including the approaches, are concreted. This construction affords permanency and minimum resistance to air flow.

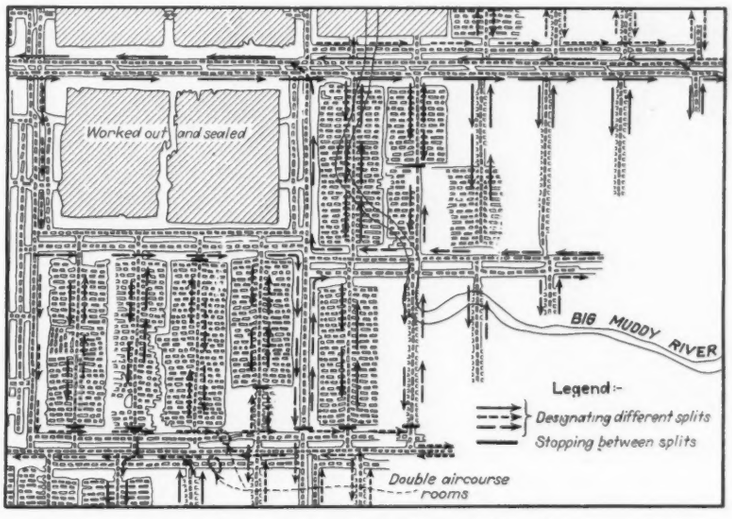
In 1936 all aircourses in No. 1 mine were cleaned from shaft bottom to ends. Joy machines were used to load the fallen top coal and shale (13,000 mine-car loads), which was dumped on the surface. Where it was advisable to replace existing untreated timber and to set timbers where none had been used, treated timbers only were put in. To make possible the haulage of material, temporary tracks of 35-lb. rail and steel ties were laid in the aircourses from cut-offs in which switches are kept in place ready for such duty.

At mine No. 2, where safety in an emergency calls for provision for cutting off the man-hoisting compartment from the return air and on to the fresh air, steel doors are in place ready to close off the heading and an airlock gives access to the intake air.

Steam fan engines at the two Zeigler fans may be connected in an emergency by moving jaw clutches. Motors are 200-hp. 2,300-volt 600-r.p.m. General Electric wound-rotor induction units and the connections are Link-Belt silent chains.

Changes at No. 5 mine of the Centralia Coal Co. in 1935 reduced the ventilating horsepower from 80 to 24½. These involved replacing an old-type steam-driven surface fan with a Jeffrey 2-stage 7-ft. Aerovane fan installed underground 100 ft. from the bottom of the escape shaft, which is now the downcast and contains a stairway. The new fan is equipped with Dodge-Timken special-duty bearings and is driven by a 40-hp. General Electric Type RC 250-volt d.c. 750-r.p.m. motor connected by 1½-in. Gates V-belts and controlled by a General Electric CR4065-C1 magnetic starter.

The fan, now operating at 537 r.p.m., is delivering 70,000 c.f.m. at an 0.8-in. water gage, but has a rated capacity of the same quantity of air at a 2½-in. water gage. Direct current to operate the fan motor normally is conducted into the mine by a lead-sheathed tape-armored cable attached to the buntons in the escape shaft. In case of trouble with this cable, the motor, by means of a double-throw switch at the fan, can be switched to the mine-power circuit, which is fed through the hoisting shaft from the d.c. generating plant. An airflow vane and contact in the heading near the fan blows a siren and lights a red lamp

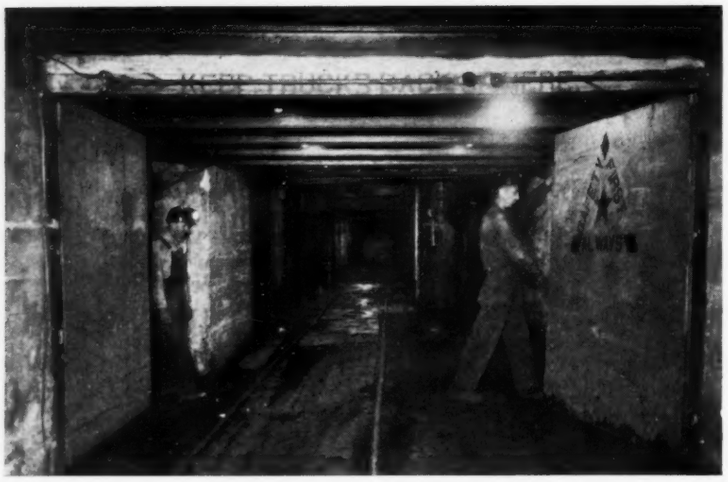


Section from a Zeigler mine map showing double aircourse rooms.

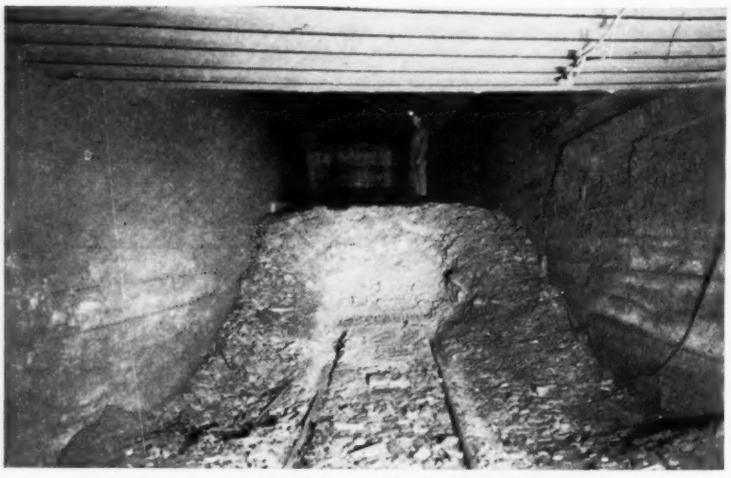
Table I—Ventilation Data, Zeigler Mines

	No. 1 Mine	No. 2 Mine
Fan	5 x 16-ft. centrifugal with reversing doors*	5 x 16-ft. centrifugal with reversing doors*
Operation	Blowing	Blowing
Regular drive	200-hp. motor†	200-hp. motor†
Auxiliary drive	Steam engine‡	Steam engine§
Cubic feet per minute	197,000	175,720
Fan pressure, inches water gage	2.7	2.2
Air-shaft depth, feet	401	310
Number air splits	Three at bottom; two auxiliary back in mine	Four at bottom; three auxiliary back in mine
Length longest split (total travel of air on main ways), feet	28,800	32,400
Downcasts	Air shaft, 10 x 10-ft. air compartment and 4 x 10-ft. curtained stair compartment.	Air compartment (10½ x 12 ft.) of air shaft.
Upcasts	Two skip-hoisting compartments (each 6 ft. 4½ in. x 7 ft. 1 in.), main shaft; one man-hoist compartment (4 ft. 3½ in. x 7 ft. 1 in.), main shaft; and man-and-material shaft (7 ft. 3½ in. x 13 ft. 7 in.)	Material cage compartment (8 ft. 1 in. x 12 ft.), air shaft; stairway compartment (3 ft. 1 in. x 12 ft.) airshaft; and main shaft 12 ft. x 21 ft. 8 in.) two car-hoisting compartments)
Number overcasts	6	3
Percentage methane, splits	0.2 to 0.40	0.10 to 0.40
Percentage methane, main return	Average approximately 0.3	0.20 to 0.25
Auxiliary blowers	None	None

* Jeffrey. † General Electric. ‡ Chuse. § Chandler & Taylor.



The man at the right is demonstrating the closing of emergency doors at foot of the man, material and air shaft, Zeigler No. 2 mine, while the man at the left is entering from an airlock connecting with downcast fresh air.



Concrete and steel construction, a concrete roof and rock-filled corners on this overcast at "B" North over the East empty track, Zeigler No. 1 mine, assure permanency and low resistance.

Discontinuing the use of an old steam unit and installing this 7-ft. 2-stage propellor fan underground at Centralia No. 5 reduced the ventilating horsepower from 80 to 24½.

in the power-house engine room in case the ventilating current should fail.

When the steam fan was in use it was connected to a 5x11-ft. air compartment in the hoisting shaft, which is 544 ft. deep, rail to rail. This hoisting shaft was completely retimbered last summer and at that time the curtain wall was removed so that the entire shaft (11x14 ft.) now serves as the mine upcast. The mine is considered non-gaseous and open lights are used.

Production, practically 100 per cent mechanical, is 1,900 tons per day, single shift. Seam thickness is 86 in. and the working height is approximately 80 in. Panels are sealed to hold back blackdamp after all rooms have been mined. The mine contains three overcasts (two now in use) and eleven doors. All headings are driven 14 ft. wide. The seals consist of 6-in. concrete walls extending from a solid bottom 2 to 3 ft. below the coal to the solid-rock top.

One-way ventilation is the rule at Mines 1 and 6 of the Crescent Mining Co., near Peoria. Here the seam worked is 52 in. thick, the cover is light and bottom is taken in haulways but not on aircourses. In places, especially in No. 6 mine, the bottom heaves and tends to restrict the aircourses. Shafts 50 to 150 ft. deep are sunk over the most distant workings to cut air travel in half. No. 1 mine produces 2,225 tons per day; No. 6, 3,400 tons.

Of the three fans in use at No. 6, the newest is a 6-ft. Jeffrey Aerovane installed at the bottom of a 70-ft. airshaft. It is driven by a 10-hp. 440-volt General Electric Type KT motor with automatic starter. All five fans at the two mines are electrically driven and are fitted with Tex-rope V-belt drives.

Installation of the Aerovane fan, the sinking of airshafts at the face and the cleaning of airways at No. 6 mine reduced the total horsepower of the ventilating load from 80 to 25 and raised the ventilating efficiency from 15 to 45 per cent. This has been accomplished in the seven years since the Bell & Zoller interests took over the Crescent mines.

Table II—Performance of Fans at the Crescent Mines.

Fan Type	R.P.M.	Water Gage	C.F.M.
	Mine No. 6		
Centrifugal*	149	0.38	15,000
Propellor*	870	0.88	26,000
Centrifugal†	185	0.50	25,000
	Mine No. 1		
Centrifugal†	335	0.88	35,000
Centrifugal*	153	0.75	21,000

* Jeffrey. † Robinson.

PUMPING AND DRAINAGE

+ Bell & Zoller Mines

FLOAT-SWITCH automatic controls are widely employed in pumping water out of Bell & Zoller mines. A gathering pump may pull from as many as seventy suction points and in one instance a 5,000-ft. suction line is used. Float-operated suction valves are widely used. At three of the five mines the water inflow is small, but, even so, equipment has been modernized to conform to the general standard of efficient operation. The water handled is not disturbingly corrosive at any of the properties.

Mines Nos. 1 and 6 of the Crescent Mining Co., Peoria, encounter the most water, even though pillars are not robbed—also the practice at the other three Bell & Zoller mines. However, the Crescent mines have a cover of a varying but light thickness which permits using boreholes and shafts for discharging water to the surface at points close to where it accumulates. A few years ago practically all of the Crescent pumps were of the reciprocating type and were operated by d.c. motors, but now a program of replacement with centrifugal pumps powered by 440-volt a.c. motors is well under way. Plain steel pipe with a maximum size of 4 in. is used in all cases in both mines.

In Crescent No. 1 mine, producing 2,225 tons per day and where more water than coal, by weight, is handled, fourteen power pumps are in use, as follows: one Goulds 4¾x5-in. duplex, two Fairbanks-Morse 6x6-in. duplex, three Gardner 4½x10-in. duplex, three Deming 6x10-in. simplex plunger, one Fairbanks-Morse 5x6-in. simplex plunger and four Fairbanks-Morse centrifugals (two No. 2 and two No. 1½). Nine of these are operated by 440-volt a.c. motors, the largest a General Electric 15-hp. unit, and five by 250-volt d.c. motors. Seven of the pumps discharge through boreholes.

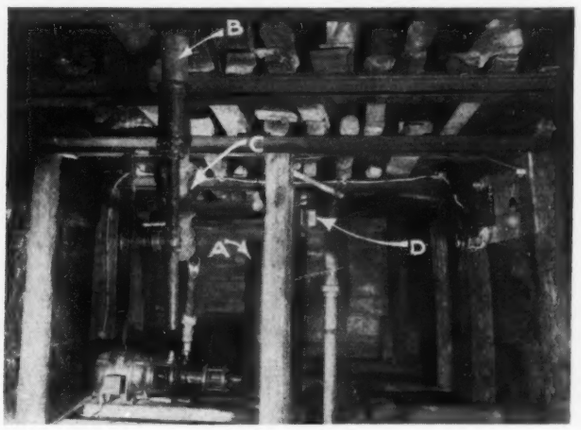
Crescent No. 6 mine, which produces 3,400 tons of coal per day, uses thirteen power pumps, viz: one Goulds centrifugal (Size No. 4), two Deming 6x10-in. simplex plunger, one Gardner 3¾x4¼-in. duplex plunger, five Gardner 4x6-in. duplex, two Gardner 4¾x4-in. duplex, one Deming 4x6-in. simplex and one Fairbanks centrifugal, Size 1½. Two of these pumps are at the bottom of the belt slope and nine are back in the mine. Four are operated by 440-volt a.c. motors, the largest (Louis-Allis) 10-hp., and nine by d.c. motors.

Where ditches are used at Crescent to conduct water to sumps they are lined with creosoted boards to help keep them open and make cleaning easier. In No. 1 mine, a gathering pump may have as many as 70 inlets, all fitted with float-operated suction valves. When water is pumped from old workings, a substance with the appearance of lime rapidly clogs borehole pipes, which must be cleaned every three months by drawing through, using a wire, cutting bits of three graduated sizes.

Centrifugal pumps are fitted with

Behind the concrete wall in the back, which acts as an air stopping across the sump, is a new centrifugal pump (Cresent No. 6). Extending down from an air shaft (left) is a 440-volt cable to the pump motor and also to a new fan installed close by.

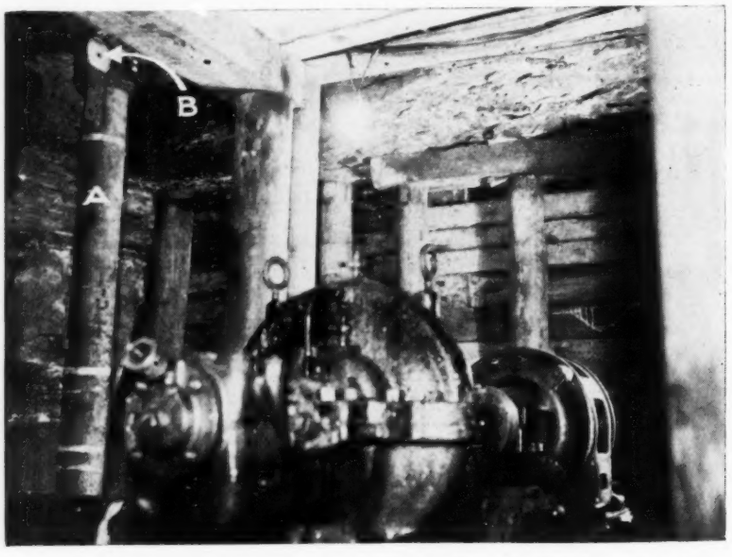
New built-together-pump installation at Crescent No. 6, separated by a concrete wall from the bottom of an air shaft. *A* is the priming tank, *B* the 3-in. discharge column entering a borehole, *C* is a check valve in the discharge, and *D* the switch with float in sump below.



priming tanks and with magnetic and float-switch General Electric motor controls. In cases where the sump is not accessible, the float switch is placed on a 6-in. open-top column pipe near the pump and connected at the bottom to the sump by separate pipe. A new Goulds pump with Louis-Allis motor at the bottom of the No. 6 mine belt slope is thus equipped.

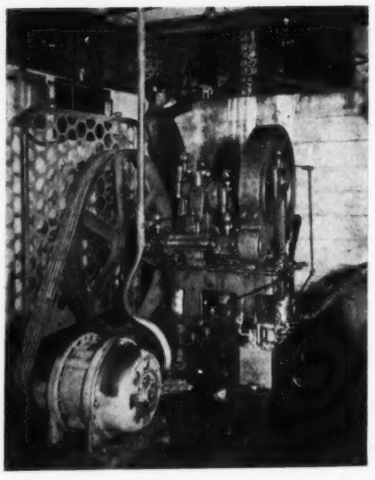
Centralia No. 5, a shaft mine, has but one power pump—a new Fairbanks-Morse 3x4-in. duplex-piston type unit installed at the bottom of the main shaft and operating against a 550-ft. head. The drive is a General Electric 15-hp. 850-r.p.m. Type RC d.c. motor with four-point series magnetic controller and float switch. Sump dimensions are 10x16 ft. by 7½ ft. deep. The water is only slightly acid but has some corrosive effect and cognizance was taken of that fact in 1929, when copper-bearing steel bodies were specified for 314 new mine cars.

Seven underground pumps make up the total in Zeigler No. 1 mine (6,900 tons per day). The mine is served by three shafts, all close together, and the water from all three is pumped to the surface through the man-and-materials shaft by a Deming triplex plunger pump driven by a 10-hp. 440-volt ball-bearing motor with a V-belt drive. Water flows by pump suction from the air shaft 700 ft. away, and that from the main shaft is forced over by a Deming "Oil-Rite" 3-hp. deep-well automatic pump. The main Deming unit is controlled automatically by float-controlled suction valves and by float switches in the sumps at both the man-and-materials shaft and air shaft.



In this new centrifugal installation at the bottom of the belt slope, Crescent No. 6 mine, the sump is inaccessible for installing a float switch but its bottom is level with the pump foundation. The 6-in. open-top column pipe, *A*, therefore was connected to the bottom of the sump to serve the float of the float switch, *B*.

This pump, with 15-hp. motor, 4-point starter and float switch, installed at the bottom of the Centralia No. 5 main shaft, handles all of the water that finds its way into that mine.



The man is pointing to the sump float switch which controls the automatic operation of this pump at the 300-ft. main shaft at Zeigler No. 2 mine.

Water from Zeigler No. 1 mine is pumped to the surface at one other point, a borehole at 11th Left one mile from the main shaft, where there is a Cameron 220-g.p.m. 500-ft.-head three-stage centrifugal pump driven by a 50-hp. motor. Two small pumps, as well as a system of ditches and a siphon, deliver to the sump of this borehole pump. Plain steel pipe is used in the mine and the maximum size along entries is 2 in.

Zeigler No. 2 mine (up to 5,900 tons per day) is dewatered by six pumps, three of which discharge to the surface. Pumping up the 300-ft. hoisting shaft is a Deming 4x6-in. triplex plunger pump driven by a General Electric 10-hp. 220-volt motor connected by V-belts. It has an automatic control and the float switch is in the adjoining concrete-walled sump, 14x60 ft. by 7 ft. deep. As a rule, the pump operates 1 hour on and 2 hours off day and night.

Water comes to this sump from a water ring in the hoisting shaft and

from a main-bottom relay pump which has a 5,000-ft. suction line and pumps from the bottom of the air shaft and from several sumps back in the mine (*Coal Age,* December, 1931, p. 617). This main-bottom relay pump, installed close to the air shaft, is a Goulds 4x6-in. triplex plunger unit driven by a 5-hp. d.c. motor. Another pump of the same make and size but back in the mine relays water to a sump where two Deming 4x6-in. triplex plunger pumps with 10-hp. motors discharge to the surface through a borehole. All pumps in Zeigler No. 2 are bronze fitted but that the water is not highly acid is indicated by the fact that only plain steel pipe is used.

Generally speaking, dewatering is not a serious problem at any of the Bell & Zoller mines. At the Crescent mines it can be classed as an irritating problem but in every case steps have been taken or are about to be taken to reduce to a minimum the daily attention required for pumping to keep the operations dry.

SAFETY

+ Bell & Zoller Mines

SAFETY at mines in the Bell & Zoller group is given equal rank with production. This policy dates back to 1929, when management accepted the principle that safety begins at the top—a prime essential in any successful program for the prevention of injuries. At that time the injury record for the five mines in the group varied from fair to poor, fair in general meaning only that fatalities were lower than the average, although total lost-time injuries, including fatalities, were high. With management actively interested, an almost immediate improvement was noticeable at some mines and eventually at all Bell & Zoller operations.

One of the most striking examples of the results of management interest since 1929 was the abrupt reversal of the trend of injuries at Zeigler No. 1 mine. For the eleven-year period 1920-30, inclusive, fatalities per year at No. 1 averaged 3.27, and in 1929 the tonnage per fatality reached a new low of 181,046, compared with the eleven-year average of 310,355. Zeigler No. 2, in the same period, averaged 1,329,943 tons per fatality, and between Aug. 7, 1928, and Sept. 27, 1931, hoisted 3,756,525 tons without a fatal injury. As a result, the mine was awarded a Joseph A. Holmes Safety Association Certificate of Merit. At No. 1, starting Dec. 6, 1930, a total of 1,912,834 tons was produced before the next fatality on Feb. 20, 1934. This improvement was recognized by a Holmes certificate, and further gains since that date, which have included producing over 2½ million tons without a fatality, have merited two additional certificates. Incidentally, Zeigler No. 1 mine has been mechanized since 1929.

As is necessarily the case, acceptance of the primary responsibility for promoting safe operation by officialdom of the Bell & Zoller group was accompanied by acceptance of three subsidiary responsibilities of a major nature: (1) maintenance of plant and equipment in the safest practicable condition; (2) establishment of standards for safe working practices, accompanied by the necessary working rules; and (3) adoption of a system for keeping the safety idea constantly before employees and instructing them in how to work with the least possible chance of injury. As in all cases where workers are convinced of the management's sincerity, the educational work growing out of the third principle generally has been matched with cordial and interested cooperation on the part of employees.

In conducting safety work, Bell & Zoller men also draw heavily on the experience and recommendations of the U. S. Bureau of Mines, the Illinois Department of Mines and Minerals, and other technical and safety organizations, such as the Illinois Mining Institute, the Mine Inspectors' Institute of America, the National Safety Council and others. So that effort could be expended in the right direction, a complete statistical set-up was inaugurated in 1929 to show the cause of each injury, part or parts of the body affected, occupation of the injured, number of days lost and the name of the supervisor under whom the injury occurred. The latter follows out the principle that officials, down to and including face bosses, are primarily responsible for injury prevention. Inauguration of the work also was prefaced by an inspection of the Zeigler properties by a Bureau of Mines representative extending over a period of several weeks, in the course of which the general outline of the program was drawn up.

Inspection, supplemented by regular cleaning up and overhauling and repairing, as the case may be, has been a major item in maintaining properties and equipment in safe and efficient operating condition. Furthermore, design modifications are made when experience or investigation reveals an actual or potential hazard. Examples are: redesign of cutting-machine skids, accompanied by definite instructions governing their use, and giving shanks on hand-auger thread bars a quarter twist to reduce the possibility of the handle coming off in service—Crescent Mining Co. mines; installation of handrails on the ends of all cars and development of a guard for the dust outlet on shortwall machines at the Zeigler mines, particularly to make it difficult to get skids into the chain; and redesign of power-driven drills at all operations, including Centralia Coal Co. No. 5, to incorporate inclosed boxing, safety cuff and inclosed thread bar.

Redesign proper also is supplemented by the use of guards. On

production equipment, an example is a hinged metal guard over the friction gear on 35-A cutting machines at Crescent. Exposed chains, belts, pulleys, couplings, gears and other moving parts are covered by screen, sheet or other types of guards, or, if guarding is impracticable, particularly on stationary equipment, it is railed off. Elevated roadways and walkways, aisles, etc., are protected by railings, and gates naturally are installed at shaft landings and at other places where men might walk into a hazard. Men working off the ground are provided with safety belts at Centralia No. 5 mine. All turnouts are equipped with bridles; all turnouts outside of rooms are equipped with throws; and all 60-lb. turnouts or other turnouts where trips are dropped past locomotives are equipped with double bridles. At the Crescent mines, where low coal limits headroom, all trolley frogs are blocked to reduce the possibility of men getting heads or necks caught.

Trolley wires are guarded at intersections or other places where men habitually pass and particularly at points where man trips are loaded. In fact, man-trip-loading stations cannot be used until guards are put up. In some instances these guards are supplemented by switches for cutting off the current. When men are required to work under the wire, temporary guards must be employed or the current cut off. At Crescent, for example, cutting off current is made possible by switches at 500-ft. intervals. All trolley and power wires are installed opposite the crosscuts, and locomotives are provided with two trolley poles. Telephone and signal lines are installed on the opposite side of the track from the power lines. All bare power lines must be kept away from coal, timbers and other combustible materials, and where they pass through doors or stoppings porcelain insulators must be installed or a 2-in. clearance provided. Doors also are being equipped with wire-glass windows so that men can observe whether equipment is coming before attempting to open them.

Bulletin boards, such as this at Centralia No. 5, give a visual record of injuries

Switchboards, starters, transformers and similar electrical equipment are inclosed or fenced off, and rubber mats or insulated platforms are provided. Ohio Brass fused trolley taps are extensively used in trailing cables for drills, cutters, loaders and similar equipment. And at Crescent, where mules are used for gathering, clevises have been substituted for hooks on tail chains and Ohio Brass insulators have been installed. Where power wires are carried across the track, insulation must be used regardless of height. Electric lights are installed along all main lines at short enough distances so that the rail is visible from one light to another. Also, electric lights are installed on all curves and at all doors, entry turnouts and other necessary points.

Supports Keep Roof Up

Roof support and clearance are major items in the program of improving physical conditions. All main roadway junctions are protected as a rule by concrete walls and points and steel crossbars, with suitable supports at temporary junctions. Systematic timbering of main lines where necessary, including proper lagging and taking down of loose material, is the rule. At the Zeigler mines, crossbars must be installed as soon as the top coal left in place breaks. Systematic timbering plans for working places, which are rigidly adhered to, have done much to reduce injuries from falls of roof or top coal in late years. At the Zeigler and Centralia mines, timbers must never be allowed to get more than 20 ft. behind the face. At Crescent, the limit is 12 ft. Rules regarding safety posts are carefully enforced. Knocking posts is severely limited and then only when the proper precautions are taken. Timber recovery is permitted, as a general rule, only by the use of post pullers, chains and jacks or other means operated from a safe point.

Minimum clearance between rail and timbers, walls, gob, etc., is 30 in. on either side of the track. This rule also applies to storing material, which must be placed where it will not interfere with the passage of men or equipment. In rooms at the Zeigler mines, for example, one post may be omitted every 30 ft. along the track, if roof conditions permit, to make a place for unloading supplies. On panel headings, no materials or supplies may be stored on the room-neck side.

Rock-dusting with M-S-A or American Mine Door machines is the rule at the Zeigler and Centralia

Table I—Salient Injury Statistics, Mines in the Bell & Zoller Group

Zeigler No. 1	Production, Tons	Exposure, Man-Hours	Injuries: Fatalities	Injuries: Lost Time	Injuries: No Lost Time	Frequency Rate*	Severity Rate
1929	1,448,364	1,264,136	9	421	695	340.15	46.3
1930	940,483	947,288	3	237	415	253.98	21.80
1931	936,785	975,648	0	113	415	115.82	1.61
1932	698,870	738,448	0	71	309	96.15	1.47
1933	559,357	607,744	0	45	250	74.04	2.09
1934	887,197	817,075	2	59	282	74.66	16.83
1935	1,209,927	1,040,739	1	64	411	62.45	8.20
1936	1,063,545	944,916	0	43	439	45.51	2.18
1937 (6 mos.)	549,995	433,601	0	21	187	48.43	1.62
Zeigler No. 2							
1929	1,329,483	1,366,160	0	275	524	201.29	6.37
1930	959,246	1,147,568	0	202	528	175.99	1.81
1931	859,849	1,075,272	1	93	518	87.42	7.87
1932	756,006	1,007,224	0	98	451	97.29	3.92
1933	964,875	1,302,432	1	104	521	80.62	6.48
1934	890,270	1,108,779	3	107	490	99.21	21.69
1935	635,932	975,128	1	64	472	66.65	9.34
1936	1,035,178	1,057,805	2	80	606	78.46	23.20
1937 (6 mos.)	550,565	484,932	0	47	285	96.71	10.85
Centralia No. 5							
1930	417,519	410,472	1	46	77	114.50	.....†
1931	292,626	264,776	1	19	54	75.53	24.65
1932	263,754	275,872	0	20	60	72.42	2.53
1933	186,095	204,704	0	9	25	43.96	2.24
1934	230,876	245,634	1	16	45	69.21	26.78
1935	286,281	294,413	0	20	88	67.93	1.17
1936	249,496	261,800	1	16	77	64.93	2.55
1937 (6 mos.)	115,616	125,902	0	8	39	63.54	.32
Crescent No. 1							
1931	310,997	463,784	1	80	111	174.65	14.65
1932	Idle	.....	...	...	...	.....	.....
1933	259,158	425,960	...	68	125	159.64	1.77
1934	295,986	451,261	...	57	134	126.32	2.45
1935	425,908	542,213	...	60	246	110.66	3.00
1936	477,550	550,137	1	44	259	81.79	11.97
1937 (6 mos.)	193,161	218,127	...	18	80	82.52	1.25
Crescent No. 6							
1931	532,374	720,784	...	118	206	163.71	2.19
1932	220,705	558,616	2	96	134	175.43	24.43
1933	744,516	1,025,680	1	132	332	129.67	8.81
1934	785,097	1,022,743	1	135	412	132.97	11.75
1935	611,683	770,731	1	76	305	99.88	9.42
1936	653,330	761,348	1	67	315	89.31	9.71
1937 (6 mos.)	212,457	341,927	...	31	117	90.66	1.96

* Based on lost-time injuries, including fatalities. † Not available.

operations. All headings, both haulage and air, must be rock-dusted before the track is removed, and all working places are dusted at intervals up to the face. Barriers consisting of ten rock-dust troughs are installed in the mouths of all panel headings or other openings into panels in which no track is laid. And at Centralia No. 5, main roadways are sprinkled regularly, using water obtained from tapping non-producing oil wells in the mine.

Systematic cleaning of tracks, roads, aisles, walkways, etc., both underground and on the surface, is a major safety practice. Particular attention underground is paid to keeping turnouts clear. Systematic recovery and storing of material both above and below is another aid to cleanliness and good housekeeping. Roadway, walkway, track, aisle, etc., condition is checked by regular inspections by the respective bosses and the safety directors for the various mines. Employees also are urged to report unsafe conditions; as an example, haulage men are expected to report the location of every derailment, even though the track shows no apparent defect.

As a corollary to regular inspection and overhauling, operation of

Table II—Lost-Time Injuries and Fatalities by Causes, Bell & Zoller Group Mines *

	Surface									Underground																		
Zeigler No. 1	Electricity	Falling Objects	Falls of Persons	Handling Tools and Supplies	Lifting	Mine Cars and Motors	Machinery	Railroad Cars and Engines	All Others	Alkali Burns — Cap Lamps	Animals	Eectricity	Explosives	Explosions — Gas or Dust	Falling Coal — Face or Rib	Roof Coal	Falling Rock and Slate	Other Falling Objects	Falls of Persons	Flying Objects	Handling Rock and Coal	Handling Tools and Supplies	Lifting	Mining Machines	Conveyor Loaders	Loading Machines	Pit-Car Loaders	Other Machinery	All Other Causes	Total
1931	..	..	1	1	...	17	1	...	...	1	...	5	1	...	11	9	2	6	8	13	...	7	9	5	9	5	..	1	1	113
1932	..	..	..	...	...	13	...	...	1	...	...	1	1	...	10	5	...	7	...	4	3	4	7	7	1	1	..	3	3	71
1933	..	..	2	1	...	11	1	...	1	...	...	3	1	...	2	1	8	2	6	...	2	1	3	..	..	..	..	..	..	45
1934	..	1	..	1	...	13	1	...	3	...	...	2	...	...	6	3	...	5	3	5	...	2	2	7	..	4	..	2	1	61
1935	..	2	..	3	2	12	1	3	2	...	...	1	...	2	4	6	...	3	1	8	1	7	4	..	..	1	..	1	1	65
1936	..	1	1	1	1	3	1	1	2	...	...	...	...	...	2	1	3	5	3	7	1	2	1	3	..	2	..	1	1	43
1937 (6 mos.)	..	..	..	...	...	7	...	...	...	...	...	...	...	...	2	1	1	2	1	2	...	1	2	2	..	..	..	..	..	..	21
Zeigler No. 2																														
1931	..	..	..	...	3	8	...	3	...	1	...	3	...	...	11	5	...	4	10	14	6	9	7	6	..	..	..	..	4	94
1932	..	..	..	1	...	13	...	...	1	1	...	...	...	...	17	4	3	4	4	20	11	5	7	6	..	..	..	..	1	98
1933	..	1	..	1	...	24	...	1	5	...	...	5	...	...	9	6	3	1	2	16	8	7	4	8	..	..	..	..	4	105
1934	..	1	1	...	...	22	...	...	3	...	...	...	...	...	15	5	3	2	4	17	7	16	7	1	..	..	..	3	3	110
1935	..	3	4	5	...	13	2	1	4	...	...	1	...	...	6	...	...	4	6	1	4	2	2	3	..	1	..	1	2	65
1936	..	..	4	2	1	32	1	1	1	...	...	1	...	...	7	...	2	4	2	3	...	4	2	9	..	6	..	..	2	82
1937 (6 mos.)	1	..	1	...	...	6	...	3	2	...	...	3	...	...	3	2	...	4	6	2	...	4	5	2	..	2	..	..	1	47
Centralia No. 5																														
1931	..	2	..	...	...	...	...	...	1	...	...	1	...	...	7	...	3	...	...	...	...	...	...	2	..	..	..	2	2	20
1932	..	..	..	...	...	...	1	...	...	...	...	4	...	...	3	1	1	1	1	1	1	2	1	2	..	..	..	..	1	20
1933	..	..	1	...	...	...	...	...	...	...	...	2	...	...	1	...	2	...	...	...	...	...	..	1	..	..	..	1	1	9
1934	..	..	..	1	1	...	1	...	1	...	...	2	...	...	1	1	4	2	...	1	...	1	..	..	..	..	..	..	1	17
1935	..	..	..	...	...	...	...	...	...	...	...	1	...	...	1	3	2	1	1	2	1	4	..	..	..	1	..	1	2	20
1936	..	1	..	...	...	...	...	...	3	...	...	...	...	...	1	1	1	1	...	...	1	...	..	1	..	..	..	4	3	17
1937 (6 mos.)	..	..	..	...	...	...	...	...	1	...	...	1	...	...	2	...	1	...	...	2	1	...	..	..	..	..	..	..	..	8
Crescent No. 1																														
1931	..	..	2	...	...	11	2	...	1	...	6	2	...	...	1	...	7	...	4	8	15	6	5	7	..	..	..	1	3	81
1932	..	..	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	..	..	..	..	..	...
1933	..	1	..	...	...	12	...	...	...	...	4	...	...	...	...	...	4	...	5	9	13	11	4	4	..	..	..	..	1	68
1934	..	1	..	...	...	5	...	...	1	...	3	1	...	...	3	1	9	1	4	6	5	3	5	6	..	..	..	..	3	57
1935	..	..	1	...	...	3	1	...	...	...	4	...	...	...	1	1	5	...	2	13	9	6	1	6	..	..	..	..	7	60
1936	1	..	1	...	...	...	...	...	...	...	2	...	...	...	2	...	8	...	4	10	4	1	2	4	..	1	..	1	4	45
1937 (6 mos.)	..	..	..	1	...	...	...	...	...	...	...	...	...	...	...	...	2	...	...	4	2	1	..	..	..	2	..	..	6	18
Crescent No. 6																														
1931	..	..	1	2	1	18	...	...	...	...	5	...	...	...	1	...	8	1	6	7	32	19	7	7	1	..	..	1	1	118
1932	..	..	1	...	...	26	...	...	...	...	5	1	...	...	...	...	3	1	7	9	25	9	4	6	..	..	..	..	1	98
1933	..	1	..	...	...	28	1	...	...	...	9	...	...	...	3	1	12	...	9	11	29	8	8	9	..	..	..	..	4	133
1934	..	..	3	1	1	11	1	1	...	...	4	...	...	...	1	2	15	6	15	22	21	10	9	10	1	..	..	..	2	136
1935	..	..	1	...	1	...	...	...	...	...	4	2	...	...	...	...	7	...	11	17	14	7	4	2	..	..	..	..	7	77
1936	..	..	..	...	...	2	...	...	...	...	3	1	3	...	2	1	5	...	5	13	12	8	1	4	..	..	..	2	6	68
1937 (6 mos.)	..	..	..	...	...	...	...	...	...	...	...	...	...	...	...	...	1	...	1	6	5	3	..	3	..	..	..	..	12	31

* Includes all fatalities and all other injuries severe enough to prevent a man from returning to work the next day.

Table III—Lost-Time Injuries and Fatalities by Occupations, Bell & Zoller Group Mines*

	Surface												Underground														
Zeigler No. 1	Blacksmiths	Bosses	Car Droppers and Trimmers	Carpenters	Electricians	Engineers	Firemen	Machinists	Office Help	Section Men	Slate Pickers	Tipplemen	Miscellaneous Top Labor	Bosses	Coal Drillers	Conveyor Shovelers	Cutters	Drivers	Electricians	Examiners	Hand Loaders	Loading-Machine Operators	Motor and Machine Repairmen	Motormen	Shotfirers	Timbermen	Trackmen	Tripriders	Miscellaneous Shift Men	Total
1931	..	..	...	2	..	..	..	1	..	..	..	1	...	2	2	34	15	...	...	...	...	13	1	5	1	3	12	14	7	113
1932	..	..	...	..	..	..	..	..	..	..	..	...	1	1	4	16	12	...	...	...	...	12	1	...	2	3	5	10	4	71
1933	..	..	...	1	..	..	..	2	..	..	1	...	1	1	4	...	4	...	...	...	...	7	1	2	1	3	1	11	5	45
1934	..	..	...	1	..	..	1	..	..	1	1	1	2	...	6	...	8	...	1	...	...	6	1	5	...	7	3	11	6	61
1935	..	..	4	2	1	..	..	3	..	..	..	..	3	2	6	...	2	...	...	...	1	4	1	5	3	2	6	11	9	65
1936	..	..	1	..	1	..	..	1	..	1	1	.....	3	.....	1	...	4	...	...	1	...	8	1	2	1	3	3	4	7	43
1937 (6 mos.)	..	..	...	...	..	..	..	..	..	..	..	...	...	...	...	...	2	...	...	...	...	1	...	4	...	3	3	3	5	21
Zeigler No. 2																														
1931	..	..	2	..	..	..	..	..	..	1	..	...	...	...	...	...	16	...	1	1	53	...	...	3	...	2	4	7	4	94
1932	..	..	...	2	..	..	..	..	..	..	..	...	1	1	...	...	9	...	1	1	64	...	1	5	...	2	1	7	3	98
1933	2	..	...	1	..	..	..	1	..	2	1	...	3	...	...	...	15	...	1	...	45	...	...	8	...	4	5	16	1	105
1934	..	..	...	..	1	..	..	..	..	..	..	..	3	...	...	...	7	...	...	...	67	1	...	3	1	3	9	14	1	110
1935	..	1	2	1	..	1	..	..	..	..	1	...	11	1	...	...	4	...	1	...	24	...	1	1	1	3	2	9	1	65
1936	..	..	1	..	1	..	1	4	..	1	2	...	1	1	1	...	8	...	...	...	7	7	1	5	1	6	6	20	8	82
1937 (6 mos.)	..	..	2	..	..	..	..	..	..	1	..	...	4	1	1	...	4	...	...	...	...	2	2	3	2	6	4	8	7	47
Centralia No. 5																														
1931	..	..	...	..	..	..	..	..	..	..	..	2	1	...	2	2	4	...	...	...	3	3	...	1	...	...	...	1	1	20
1932	..	..	...	..	..	1	..	..	..	..	..	1	...	...	2	...	5	...	...	...	3	3	...	1	...	...	1	3	...	20
1933	..	..	...	..	..	..	1	..	..	..	..	...	...	...	3	...	1	...	...	...	...	1	...	2	...	...	...	1	...	9
1934	1	..	1	..	..	1	1	..	..	..	..	1	1	1	1	...	...	...	1	...	1	3	...	2	...	1	...	1	...	17
1935	..	..	...	..	..	..	..	..	..	..	..	...	...	1	...	1	...	...	3	...	2	4	2	...	...	1	2	3	1	20
1936	..	..	...	..	..	..	1	..	..	..	1	1	...	...	...	...	2	...	...	...	3	2	2	...	...	...	...	4	1	17
1937 (6 mos.)	..	..	...	..	..	..	..	..	..	..	1	...	...	...	...	...	...	...	1	...	3	1	...	...	...	1	...	...	1	8
Crescent No. 1																														
1931	..	..	...	..	..	..	..	..	..	..	..	...	2	...	1	...	6	14	1	...	48	...	...	1	...	3	1	2	2	81
1932	..	..	...	..	..	..	..	..	..	..	..	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1933	..	..	...	1	..	..	..	..	..	..	..	...	2	1	...	...	6	16	...	...	35	...	...	1	...	2	3	...	1	68
1934	..	..	...	..	..	..	..	..	..	..	..	1	1	...	1	...	5	6	...	...	31	...	...	2	...	5	1	3	1	57
1935	..	..	...	..	..	..	..	..	..	..	..	1	...	...	1	...	6	8	...	...	35	1	...	...	...	2	3	1	2	60
1936	..	..	...	..	..	..	..	..	..	..	..	...	1	...	1	...	6	5	1	...	22	1	...	...	...	3	...	3	2	45
1937 (6 mos.)	..	..	...	..	..	..	..	..	..	..	..	...	1	...	...	...	2	3	...	...	8	2	...	...	...	2	...	...	...	18
Crescent No. 6																														
1931	..	..	...	..	..	..	..	1	..	..	..	...	3	...	...	1	7	11	3	1	75	...	...	...	1	3	7	2	3	118
1932	..	..	...	..	..	..	..	..	..	..	..	...	...	...	5	...	11	22	...	...	51	...	...	1	3	2	2	1	...	98
1933	..	..	...	..	..	..	..	..	..	..	..	...	3	1	...	...	14	19	2	...	81	...	...	...	...	2	4	1	6	133
1934	..	..	...	..	1	..	..	4	..	..	1	3	...	...	...	...	17	10	...	...	82	...	...	...	2	2	8	2	4	136
1935	..	..	...	..	..	..	..	..	..	..	..	..	1	...	...	...	4	6	2	...	58	...	...	1	...	...	1	2	2	77
1936	..	..	...	..	..	..	..	..	..	..	..	...	...	...	...	...	8	10	1	...	42	...	...	...	...	1	3	3	...	68
1937 (6 mos.)	..	..	...	..	..	..	..	..	..	..	..	...	...	...	...	...	4	3	...	...	18	...	...	1	...	1	...	2	2	31

* Includes all fatalities and all other injuries severe enough to prevent a man from returning to work the next day.

Table IV—Fatalities and Lost-Time Injuries by Parts of the Body Affected, Bell & Zoller Group Mines*

Zeigler No. 1	Fatalities	Eye	Face	Head	Back	Hernia	Trunk	Arm	Hand	Thumb or Finger	Hip	Leg	Foot	Toe	All Others	Total
1931	...	14	6	4	15	...	7	7	7	14	3	8	14	14	...	113
1932	...	4	2	4	9	...	4	6	2	8	1	13	9	9	...	71
1933	...	5	...	...	4	...	2	5	2	8	...	8	7	4	...	45
1934	2	6	2	1	4	1	2	1	4	7	2	10	11	8	...	61
1935	1	8	4	2	4	3	6	5	5	12	...	6	6	2	1	65
1936	...	7	1	...	5	...	1	3	...	10	...	3	9	1	3	43
1937 (6 mos.)	...	2	...	...	3	1	1	2	...	3	...	4	2	3	...	21
Zeigler No. 2																
1931	1	12	1	...	11	...	5	8	6	10	3	8	16	13	...	94
1932	...	17	1	6	6	1	11	2	8	6	1	11	13	15	...	98
1933	1	20	3	2	9	1	7	6	7	14	3	8	13	11	...	105
1934	3	19	...	...	7	...	8	12	5	20	2	9	16	7	2	110
1935	1	7	2	2	6	1	5	2	3	13	...	9	8	4	2	65
1936	2	6	2	1	4	2	6	8	5	17	2	8	12	6	1	82
1937 (6 mos.)	...	3	1	...	7	1	4	3	8	8	1	7	2	1	1	47
Centralia No. 5																
1931	1	1	...	2	2	...	...	1	1	2	...	5	2	3	...	20
1932	...	1	...	1	1	...	...	1	4	3	1	2	6	...	...	20
1933	...	...	...	...	...	...	...	1	4	...	...	3	...	...	1	9
1934	1	1	...	...	2	...	1	...	2	3	3	2	1	1	...	17
1935	...	1	...	...	4	1	1	1	2	2	1	2	3	2	...	20
1936	1	1	...	...	1	...	2	1	3	2	...	1	5	...	...	17
1937 (6 mos.)	...	4	...	...	1	...	...	1	...	1	...	1	...	...	...	8
Crescent No. 1																
1931	1	10	5	3	12	2	8	1	7	10	1	10	11	...	...	81
1932	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
1933	...	12	1	2	5	1	9	7	3	12	...	7	6	3	...	68
1934	...	6	...	...	8	3	...	3	6	8	2	13	6	2	...	57
1935	...	11	1	...	7	...	3	3	4	8	1	11	10	...	1	60
1936	1	12	...	...	8	...	4	...	1	6	1	7	4	...	1	45
1937 (6 mos.)	...	6	...	...	1	...	1	1	1	2	...	1	2	...	3	18
Crescent No. 6																
1931	...	14	2	1	25	2	8	7	4	18	2	14	15	6	...	118
1932	2	14	3	2	11	3	6	4	4	16	...	13	16	3	1	98
1933	1	16	6	2	15	1	15	2	9	24	...	17	17	6	2	133
1934	1	21	4	3	15	2	10	10	13	18	5	17	14	3	...	136
1935	1	13	3	...	11	1	4	3	1	6	1	15	15	3	...	77
1936	1	13	3	1	8	...	4	1	6	12	4	9	5	1	...	68
1937 (6 mos.)	...	7	1	1	...	...	4	...	4	5	...	1	4	1	3	31

* Includes all fatalities and all other injuries severe enough to prevent a man from returning to work the next day.

a bad-order machine is forbidden. Operators are expected to report any defects immediately and shut down the equipment if serious. Rigid rules require stopping equipment and cutting off the power before repair work is attempted, supplemented by posting of warning signals when necessary. The rule against defective equipment also runs to tools. Bad-order tools are not supposed to be used, and in the case of company-owned tools supervisors must send them out for reconditioning when necessary.

The safety work of Bell & Zoller supervisors, particularly those in direct contact with the men, is coordinated and given force and direction by safety engineers, who also function as inspectors, investigators, advisers and keepers of the records and oversee first-aid and mine-rescue training, as the case may be. Safety engineers also are responsible in large measure, together with the higher officials, for prescribing and directing educational work.

The groundwork for safe practices for both supervisors and employees is supplied by a set of rules drawn up for each mine group: i.e., the Zeigler mines, Centralia No. 5

and the Crescent mines. Rules are kept as few as possible in number and, while generally the same, vary in certain respects to meet conditions at the several operations. For example, at Crescent, primarily hand loading, loaders are forbidden to drop or push loaded cars out of the place. Also, as no cages are used, the rule covering the proper methods of getting on and off and riding on man cages is eliminated.

At the Zeigler mines, where Edison electric cap lamps are used, smoking materials, matches and smoking are prohibited underground. Also, as electric lamps make possible an automatic check of employees, the rule regarding life checks in force at Crescent and Centralia is omitted at Zeigler.

Rule lists for the various operations are posted, and have, under the provisions of Sec. 23-d, General Mining Laws of Illinois, the force of law. All such rule lists contain prohibitions against disorderly conduct, such as scuffling, wrestling, pushing, fighting, and horseplay in general; against climbing over or through trips except in performance of necessary work; against bringing liquor on the property or coming to work under its influence; against riding on trips or haulage units without authorization; against leaving working places or making unauthorized visits to other parts of the mine or plant; against entering working places which have been marked out by the examiner unless specifically authorized; and against tampering with or stealing first-aid materials.

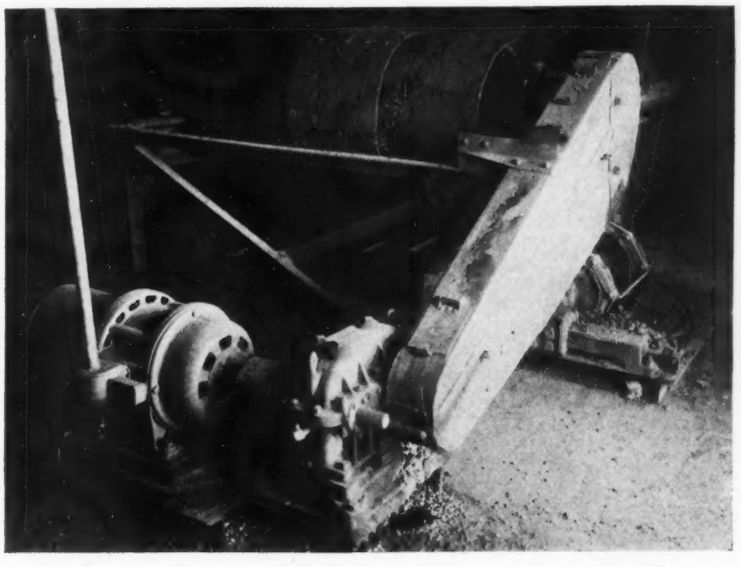
Rules Govern Conduct

The rules also make it mandatory for employees to board or leave man trips only at designated points, to walk to and from the trips and to remain seated while in the cars. Where permissible powder is used, miners are required to drill new holes alongside missed shots, not closer than 12 or 18 in., depending upon the mine. Posts must be set at least 30 in. from the rail and not more than 20 ft. back from the face, except at Crescent (20 in. and 12 ft.).

Injuries from the sumping of cutting machines and the improper use of skids have resulted in specific instructions that all sumping must be done on slow feed. At Crescent, for example, the average was two serious injuries per year from high-speed sumping up to June, 1935. Since that time, none have been experienced. The extra time for slow-feed sumping was reduced 1 minute by the use of hooks on jack pipes to facilitate changing ropes, leaving a handicap of only 4 minutes. Even at that, however, machine crews still cut the same number of places, due to insistence on loaders properly cleaning and squaring up faces, which was a part of their duties anyhow. Skid injuries, at one time a major item, have been sharply reduced at Crescent by redesigning skids, limiting the number per machine and specifying the method of use. At the Zeigler mines, skid guards must be in place before the machine can be operated, and machine men are prohibited from placing skids under the right-hand side while the chain is in motion. At Centralia, the chain must be stopped before skids are placed. Men are required to stay off the cutter bar when traveling, and the helper must go ahead when the machine is on the entry.

The rule on which the greatest stress is laid, however, is as follows: "Employees working at or near the face shall consider their first duty at all times to be to make the place safe before doing any other work. Sound top! Sound face! Sound ribs! Take down loose top! Take down overhanging coal! Set props! If necessary, set sprags!" This rule runs just as strongly for supervisors as employees, and loading-machine bosses in particular are expected to inspect each place just before the loading machine enters it. Failure to do this has involved several bosses in difficulties.

Rock-dusting is carried into room entries and rooms at regular intervals



Safety guards protect all moving machinery and parts at Bell & Zoller mines

Well-dressed Bell & Zoller workers—safety shoes and headgear, electric cap lamps and goggles

Formal posted rules are supplemented by other rules designed to improve operating practices. In many cases these rules are applicable to conditions peculiar to a single mine, a single occupation or a single type of equipment. One fairly general principle, however, is the prohibition of loose clothing for haulage men—particularly loose pants legs on tripriders—and men working around moving machinery. Operation of cutting machines with loose or long bits is frowned upon, and timbermen are instructed to keep their thumbs off the tops of cap boards, wedges, etc., when using an axe. Axe-handle length, also, is limited to 20 in. at Zeigler. Men operating cutting machines, drills, etc., are expected to block switches when working in a place to prevent cars being kicked in on them.

Tripriders at Crescent mines must wait until the trip slows down before getting on and off, while motormen must stay on locomotives while they are in motion, except in emergency, and must not start trips without a signal. Man-trip speed is limited to 500 f.p.m., and the minimum distance between trips to 200 ft. At Zeigler, kegs must be destroyed when empty to prevent men from using them as stands, and locomotives, except in motor pits, must be parked either bumper to bumper or 25 ft. apart. These examples might be multiplied indefinitely, but sufficient are given above to indicate that establishment of standards for working is an integral part of the safety program.

Specific instructions regarding reporting all injuries, no matter how trivial, accompany each posted set of rules. In each case, men are requested to make such reports to their immediate supervisor if possible; otherwise to some person in authority or to the mine office. This is a prerequisite to the issuance of an order to the doctor for treatment. At the Zeigler mines, where men must turn in their lamps when leaving the mine, such orders are issued by the timekeeper at the lamp house, who at the same time makes out an accident report. At other mines, accident reports are made out and doctor's orders are issued by the supervisor or other authorized person to whom the injury is reported. At Centralia and Crescent, copies of the accident reports go to the safety engineers, while at Zeigler reports are submitted to the compensation adjuster each day by the supervisors.

When the injured man reaches the doctor, the latter fills out a first-aid report, including the patient's story of the injury, its nature, the treatment in detail; whether the man is sent back to work, to his home or to the hospital; probable date when the man will be able to return to work and an estimate of the permanency of the injury. When the injured is able to return to his duties, he is furnished with a release, at which time the doctor makes out a final report. The release must be presented to the foreman; otherwise the man cannot work. In case the man fails to show up at the end of the set period of disability, it is the duty of the safety engineer or compensation adjuster to find out why. The major objectives of the system just described are two. One is to insure that every injury receives immediate attention as required, and the other is to keep down the period of disability and see that the man returns as soon as he is able.

Safety engineers examine all working places under and above ground at least once a month; correct and report unsafe practices to foremen with, at Zeigler, in the case of major offenses, reports to higher officials up to and including the assistant general manager; take air readings monthly or oversee this task (at the Zeigler mines, methane content is checked with a U.C.C. detector); check safety wearing apparel and promote its use, including making or overseeing correct fit; clean and post safety bulletin boards; check and file all reports of injuries; investigate all serious, lost-time and fatal injuries personally, develop the causes, place the responsibility and follow through with definite recommendations to prevent a recurrence (separate investigations, reports and recommendations also are made by supervisors); and keep monthly records of injuries by causes, occupations and parts of the body affected, in addition to frequency and severity rates and the ratings of the various supervisors.

Bosses Help on Standards

In view of the vital position of the supervisor in the safety set-up, he is given every opportunity to help set up the standards to which he must work. Monthly meetings are held, at which higher officials, the safety engineers and representatives of the compensation department are present. At these meetings, supervisors present written reports of all lost-time injuries, each with his definite recommendations. These are discussed at the meeting and final standards effective in all departments to which they are applicable are set up. In addition, supervisors are regularly furnished with reports of their standings, with pertinent information on safety compiled by safety engineers and higher officials and with reports and releases of state and national safety departments, as well as various independent safety organizations. Publication of their ratings in the *Safetygram*, a monthly publication distributed to all Bell & Zoller employees and officials, at the end of every six months, is another spur to excellence. When the present program was inaugurated, personal letters were sent to all supervisors by the operating vice-president, and this practice still is followed by higher officials, supplemented by person-to-person chats in the case of super-

visors who seem to be falling behind.

In addition to seeing their names high up in the rating lists, supervisors also receive cash for good records. These rewards are set up on an annual basis, and each supervisor is allowed 2¾c. for each man-hour of exposure in his territory. Against this allowance is charged the cost of all injuries in his section, including overhead (safety engineer's salary, compensation-department operating cost, etc.). Then, at the end of the year, the foreman is paid a certain percentage of the difference between the total allowance and the total cost of injuries, provided, of course, the latter is the smaller. If the injury cost is over 2½c. per man-hour and less than 2¾c., the supervisor receives 10 per cent of the difference; if the injury cost is less than 2½c., the supervisor in question gets 40 per cent of the difference. Rewards on this basis have run into hundreds of dollars in some cases, with corresponding savings to the company. Along with the possibility of reward, supervisors, under a policy now being developed, also run the chance of discipline in the form of lay-off or discharge for flagrant lapses in duty, particularly when injury results. Thus, their place in the scheme of things is brought home in still another fashion.

Contact Promotes Safety

Instilling the safety idea in the minds of the men is primarily a matter of personal contact with foremen and safety engineers, but in addition a wide variety of educational measures, ranging from bulletins and first-aid training to safety essays by school children, are employed. As a starter, each employee receives a copy of the *Monthly Safetygram,* which, in addition to general news and personal items about workers and their families, includes a description of every injury incurred during the preceding month, together with the name of the supervisor in charge. Special messages covering certain hazards or injury trends and general material on injury prevention are other features.

Well-kept, well-lighted and attractive bulletin boards are erected at each mine. In addition to safety posters issued by the National Safety Council and Elliott Service mining division, special posters are made by company employees. And in addition to bulletin boards, posters are placed in wash houses, on walls, on mine cars and in other places where there is a chance that they will catch the eye. Each mine also is equipped with a safety board, made with lamp sockets for each day in the month. Red lamps are used to indicate days on which injuries occur. Naturally, the desire of all is to keep red lamps off the board.

Another method of keeping interest alive is distributing safety hints with pay checks from time to time. At the Crescent mines, the usual "Good morning" or other salutation recently was replaced with a safety message selected from those submitted by employees. The first was "Safety First." Each such greeting is used for a month, and then replaced by another. Safety also is carried into the home by awarding prizes for the best essays on safety subjects to children of employees at all mines in the Bell & Zoller group.

At Centralia No. 5, formation of a chapter of the Joseph A. Holmes Safety Association has been a major factor in keeping alive the idea of injury prevention. This chapter was established in November, 1935, and is the only one in Illinois. Meetings, usually with an attendance of about 70 per cent, are held once a month. One hour is devoted to a discussion of injuries and methods of preventing them. This is followed by an hour of entertainment and refreshments. At two meetings a year, all members of the employees' families are invited, and attendance at these affairs has run as high as 550. All expenses of operating the chapter are borne by the company. A Centralia employee, Henry Litchenfeld, still working, was awarded a Holmes certificate in 1933 for working 50 years without a lost-time injury.

Suggestions from employees are an integral part of the Bell & Zoller safety program. Whether formal or informal, such suggestions are sought and given careful consideration, and suggestion boxes are installed for those who desire to make a formal presentation.

Taking a page from radio broadcasting, "safety broadcasting stations" have been installed at the Zeigler Nos. 1 and 2 and Centralia No. 5 mines. These stations include equipment for broadcasting both voice and music directly, as well as phonograph recordings. The first station, SAFETY, was installed at Zeigler No. 1, June 5, 1935; next was THINK, Centralia No. 5, Dec. 9, 1935; third was ABC (Always Be Careful), Zeigler No. 2, March 30, 1936. No stations have been installed at Crescent because the arrangements for handling men are such that it is difficult to get large groups together.

At Zeigler No. 1, amplifier and microphone are placed underground, while at the other stations the amplifying equipment has been placed on the surface, with microphones at strategic points on the surface and underground. Placing the amplifiers on the surface and using a number of microphone stations both above and below eases the problem of studio broadcasts by guests, individually or in groups, and also allows the safety engineers and mine officials to talk from different points. In general, speakers are placed so that they can be heard by men in place in man-trips before they start for the inside, with supplemental speakers at Zeigler No. 2 and Centralia No. 5 in wash houses, meeting rooms, etc.

Broadcasts are made every day the mines operate, starting with recordings or guest programs until ten minutes before the man-trips leave,

First of the Bell & Zoller safety broadcasting stations at Zeigler No. 1 mine

at which time a safety message, never more than five minutes long, is delivered. Usually, these talks are devoted specifically to safety in and around the mine, and may be general or directed to specific occupations, but deviations include addresses on highway safety, safety in the home, etc., in many cases delivered by guests. Excluding the cost of cables and wire, expenditures for the various stations were: SAFETY, $332.50; THINK, $300; ABC, $453.20.

First-aid training is another means of stressing the safety idea, in addition to its primary objective of fitting men to take care of injuries. The goal, as closely as it may be approached with the usual employee turnover, is 100 per cent training, which is accomplished by offering the course, with the cooperation of the Illinois Department of Mines and Minerals and the U. S. Bureau of Mines, every two or three years. In addition, teams at each mine are kept constantly in training in regular meetings. A rescue station, with six sets of Gibbs apparatus, is maintained at the Zeigler mines, and twelve men are kept constantly in training by monthly sessions.

First-aid kits or cabinets in charge of section foremen or department heads are maintained in each section of the mine or plant, as a rule, but on Sept. 1, 1934, the use of portable kits was adopted at Crescent Nos. 1 and 6 mines. Each underground foreman is supplied with a kit containing sufficient material to take care of any injuries during the shift, and additional kits are supplied to the first-aid teams. These kits are brought out to the warehouse each night, where they are checked and missing supplies replaced. Major advantages are availability of material at all times, due to elimination of pilferage and unreported use, and adaptability of the kits to being taken directly to the scene of the injury. Adoption of a similar system is under consideration at other Bell & Zoller group mines.

Cash incentives for safe working also are offered employees through the medium of "bank days." Every time a mine works 2,500 injury-free man-days a "bank day" is declared, the "bank" consisting of $40 contributed by the company. To be eligible to participate, employees must have worked every day during the period, although an excuse from the mine manager prior to absence makes a man who has lost a day still eligible. To make sure that there are no omissions, a list of eligibles is prepared and posted. The second night following, at quitting time, the men draw lots for the $40, which is divided into eight $5 prizes.

Protective clothing is an integral part of the Bell & Zoller safety program. All mines are 100 per cent safety headgear and footgear. Goggle introduction is proceeding as fast as possible at all mines but Crescent No. 1, which is on the 100-per-cent basis. Particular interest in goggle use at the Crescent mines grows out of the fact that the coal is low and quarters therefore are more cramped, increasing the possibility of eye injuries from flying particles when using picks and other tools. Consequently, goggles were installed at No. 1 as the first step to 100-per-cent use at both operations. To make sure that all men at least have their goggles with them, each man's life check is riveted to his goggle case and a rack is installed for their reception at the end of the working shift. In other words, goggles are handled at Crescent No. 1 in the same fashion as electric cap lamps at the usual operation. Turning in goggles each night also gives the safety engineer a chance to examine and clean them when necessary.

Goggles Cut Eye Injuries

Investigation has shown that 25 per cent of the men at Crescent No. 1 wear their goggles all the time; 50 per cent about half the time; and the other 25 per cent occasionally, as their work dictates. The goal is 100 per cent all the time. Since use started in September, 1936, eye-injury frequency and severity rates have been reduced approximately 40 and 15 per cent, respectively. At other operations of the company, goggles are being pushed for all tasks involving picking, chipping, cutting, etc., where there is a possibility of flying material. Prescription-ground lenses are furnished when necessary.

Men also are requested to wear gloves when handling coal, rock or other similar material, particularly at the Crescent mines, primarily hand loading. Leather-palmed gloves are prescribed for drillers at the Zeigler and Centralia mines. Protective clothing is sold either on the cost-plus-handling-charges or flat-price basis, depending upon the mine and the type of protection. Flat prices are in all cases less than cost. M-S-A headgear at Zeigler and Centralia, "W.B.C." headgear at the Crescent; International shoes and American Optical goggles are stocked at the supply houses. Except for special work, spectacle-type goggles are standard. Fitting of shoes and headgear, particularly, is done by the safety engineers, or by supply men, in the latter case after undergoing a training course.

Goggle rack at Crescent No. 1 mine. Life checks are riveted to goggle cases

MAINTENANCE

+ Bell & Zoller Mines

PREVENTION of delays ranks first but the costs of preventing possible delays get close scrutiny—these facts stand out in a study of maintenance methods of the five mines of the Bell & Zoller group. Maintenance methods at the two largest mines, Zeigler No. 1 and Zeigler No. 2, which together hoist nearly 13,000 tons of mechanically loaded coal per day, are similar except for slight variations instituted by the respective chief electricians. Methods at Centralia No. 5, another mechanical mine, and at the two Crescent mines, near Peoria, show variations because of differing conditions and because they are under separate local managements.

Loading machines at Zeigler No. 1 mine, where mechanization began in 1929, are as follows: Goodman, 1; Joy 7BU, 1; 5BU, 10; and 11BU, 7. At Zeigler No. 2, which is two miles west and was completely mechanized in 1935, the equipment consists of seven Joy 5BU and ten Joy 11BU machines. The mines are served by 300-ft. and 400-ft. shafts, the coal seam lies practically level, the workings are dry, considerable methane is encountered and the working height is 8 ft.

As indicated in Table I, the total cost of loading-machine maintenance at No. 1 mine averages approximately 3¼c. per ton and comparison with 1936 shows that, in spite of higher material and labor costs, the maintenance cost is being reduced. In this improvement at No. 1, full advantage has been taken of the nine years of mechanical-loading experience. As might be expected, maintenance costs are not so favorable at No. 2 mine, in which loading-machine experience has been short and where all additional maintenance men were recruited from men who had been working at other jobs and some of whom still are mechanics in the making.

That total mine maintenance cost has been practically doubled by mechanization is indicated by Table II. Because the comparison is between two mines with some variables, emphasis should not be placed on the exact figures. It will be noted that the figures indicate approximately an 8c. increase by reason of mechanization, not allowing for variations in loading-machine-maintenance cost shown in Table I. Other items of equipment auxiliary to mechanical loading account for at least a portion of the difference.

Maintenance of top equipment is under a master mechanic or top foreman; underground equipment, a chief electrician, one man in each position for each of the Zeigler mines. Table III sets forth the duties of the 42-man crew under the chief electrician at Zeigler No. 1 mine. The top foreman at this property has a crew of 44 men, including power-plant operators and repairmen, hoisting engineers, shopmen and a few men for miscellaneous duty. The tipple force at this mine is small because all coal is shipped as run-of-mine Ziegler No. 2.

So that there will be no divided responsibility in the maintenance of underground machinery, it is the practice at both mines to have portions of the top shops allotted as working spaces to two men who report to the chief electrician. Most of the work in these sections consists of building and rebuilding parts and assemblies for Joy loaders. Constructing replacement heads for these machines by arc-welding is a large part of this division of top-shop work supervised by the chief electrician.

An average of the grand totals of the detailed items of electrical department expense at the two Zeigler mines (Table IV) is 11.6c. per ton, approximately 75 per cent of the total operations maintenance cost excluding the central cleaning plant.

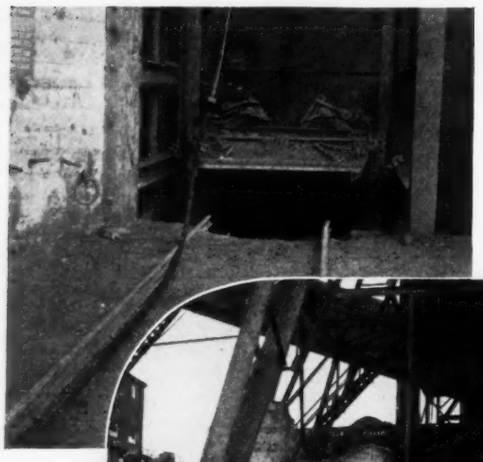
Routine at No. 1 mine in inspection and handling and reporting of repairs, necessary and completed, is as follows: Each day at the end of the work shift the chief electrician meets the section foremen in the lamp house and there receives from each a report of condition of the equipment in his section. When any loading machine or its cutting machine or drill is reported defective the chief electrician notes that defect on a form—the "Repairman's Daily Report" (Fig. 1). This report goes to the night mechanic and helper who will service and grease the machine. On this same form these men note the repairs made and quantity of grease and oil used, leaving the form on file for the chief electrician to inspect the next day.

Once each week each machine is given a thorough inspection by these same night men, who check the condition of every part, recording their findings on another form, "Repairman's Weekly Inspection Report" (Fig. 1). All locomotives are taken to the main bottom after the working shift and are serviced on the two off-shifts by four of the six locomotive repairmen. These men also look after the charging of six Mancha storage-battery locomotives, equipped with Philco 48-cell 39-plate batteries. All other locomotives servicing loading machines in this mine are 6- or 8-ton cable-reel units.

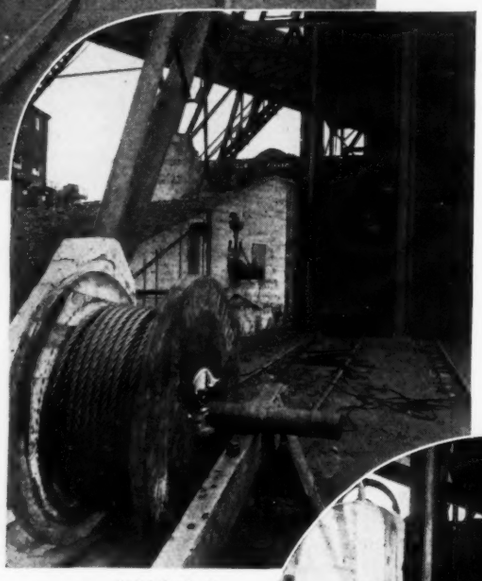
A separate shop on the surface at No. 1 mine is equipped with a tire-turning lathe and double-unit automatic arc-weld tire-filling equipment consisting of a lathe fitted with General Electric automatic welding heads supplied from two 300-amp. special welding-type motor-generators. Only the tires of gathering locomotives are thus filled, as the management thinks the method too risky for main-line locomotives. The No. 1 mine machine serves also to weld tires sent over from No. 2.

After the tires (mounted on their trucks) are put into the welding lathe they first are heated with a kerosene torch to 300 deg. F. If the weather is medium to warm, the torch is cut off before welding; if

HOISTING 5,900 tons 345 ft. in 7 hours in one shaft on single-deck cages calls for a rapid acceleration and a speed which is a severe duty on ropes and cages. Here we see the steps in a rope renewal at Zeigler No. 2



(1) The cage is fastened at the landing by heavy chains

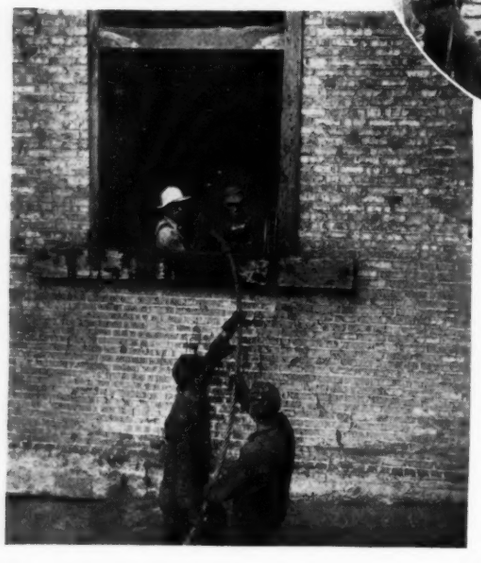


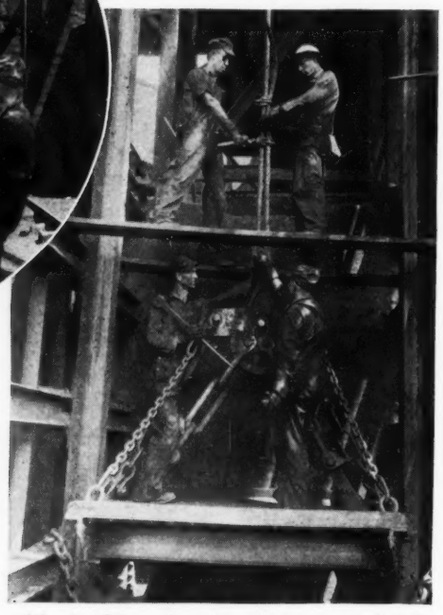
(2) The new rope (1½-in.) is being pulled into place by the old rope as the latter is being stretched out onto the ground by a motor truck

(4) Clamping the rope temporarily to the timble

(5) Hoisting the thimble for connection to the cage chains

(3) Passing the end of the new rope into the hoist house ready for attachment to the drum





(6) Applying the nine clamps spaced 9 in. apart. The rope manufacturer recommends that the U-bolts clamp against the dead rope but at this mine the clamps are alternated because experience indicates that method serves best

Table I—Maintenance Costs, Loading Machines, Zeigler Mines, First Quarter, 1937 and 1936

No. 1	1937 Output, Tons	1937 Cost per Ton: Labor	Supplies	Total	Supplies, Lubrication Only	1936, Total
January	121,559	$0.0207	$0.0192	$0.0399	$0.0024	$0.0407
February	135,997	0.0170	0.0142	0.0312	0.0031	0.0310
March	159,239	0.0169	0.0070	0.0239	0.0028	0.0545
No. 2						
January	114,765	$0.0387	$0.0400	$0.0787	$0.0030	$0.0438
February	128,632	0.0257	0.0360	0 0617	0.0073	0.0509
March	149,130	0.0262	0.0263	0.0525	0.0053	0.0715

Table II—Comparison Between Total Maintenance Costs With Hand and Mechanical Loading, Zeigler Mines*

	No. 1 — 100 Per Cent Mechanical Loading: Output, Tons	Cost per Ton: Labor	Supplies	Total	No. 2 — Still on Hand-Loading Basis: Output, Tons	Cost per Ton: Labor	Supplies	Total
February, 1935	111,097	$0.071	$0.108	$0.179	79,021	$0.0570	$0.0395	$0.0965
March, 1935	119,180	0.061	0.096	0.157	70,314	0.0462	0.0326	0.0788

* Includes all renewal timbers and rails, but, as such renewals were few, both such items are small. The new central preparation plant for both mines was yet to be put in operation at the time covered by this table.

cold, torch heating may be continued during welding. Peening is done between layers and usually an air hammer is used for this purpose. The welding is done with a ¼-in. rod, both tires at the same time, and while that is going on the attendant is turning previously welded tires in the other lathe.

Hoisting ropes at Zeigler No. 1 must be renewed after handling 600,000 to 900,000 tons, which means 7 to 10 months' service. At the time of this writing a Roebling 1½-in. 6x19 "Blue Center" rope was in use on a steam hoist handling 17-ton skips (coal, 9½ tons; skip, 7½ tons) over a total distance of 460 ft. Ropes complete their initial stretch in two to three weeks. After six months or more of service, the second stretch begins and it is at this time that special inspections are made by caliper and vision to locate reduction in diameter, flat places and broken wires.

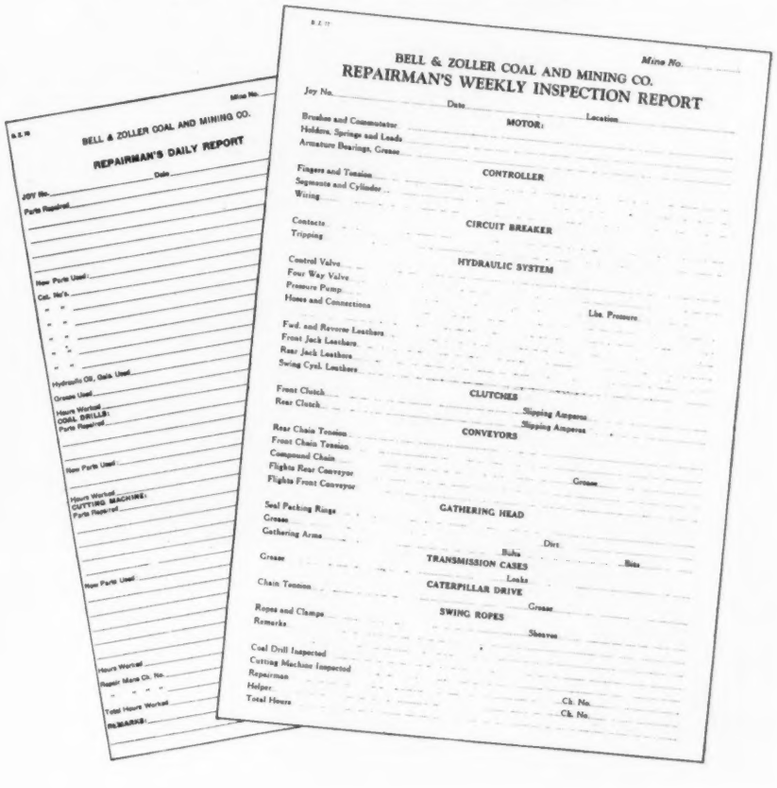
Power-house maintenance at No. 1, as a rule, is taken care of by the regular force. Other top equipment to be maintained consists of three standard-gage rod locomotives, two 1½-yd. clamshells and a small steam shovel.

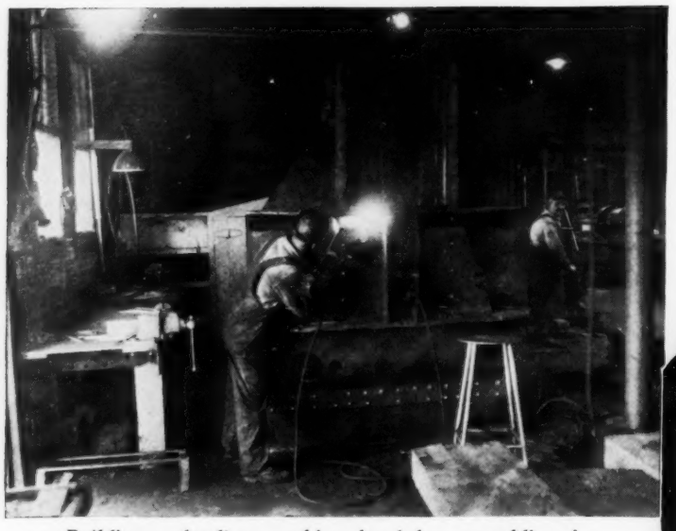
Mining-machine bits for No. 1 mine are hard-surfaced at the tip with Haynes Stellite; Borod is used at No. 2. Cutting conditions in the two mines are similar and results with the two types of hard-surfacing are not materially different. In both mines the bits are reground to renew clearance by substation operators as long as there remains a serviceable amount of hard facing on the point. At benches close to the substations, which they attend, these operaors have United States Electric Tool Co. double-wheel, 1¼x10-in., adjustable-guard, 1,750-r.p.m., 250-volt, 4-amp. grinders. About 60 per cent of the bits used each day are reground.

A test made at Zeigler No. 2 mine in June, 1936, soon after a Sullivan bit-sharpening and hard-facing plant was installed and while the daily tonnage averaged 4,600, showed the following: 1,137 bits used per day, 692 bits reground per day, 451 bits rerolled and tipped per day, 4 tons cut per bit used and 10.2 tons cut per bit rerolled and tipped (*Coal Age*, September, 1936, p. 367). Total labor and material cost of bit sharpening was $0.00135 per ton, compared to $0.0032 when bits were treated by quenching in a soap-water bath.

Maintenance of the 1,000-tons-per-hour preparation plant at No. 2 is handled by a crew of 25 men who report to the preparation-plant superintendent. Seventeen of the maintenance crew work on the third, or off, shift (the plant operates two shifts when both mines run the same day), as follows: one master mechanic, one electrician, one electrician's helper, one screen inspector and repairman, one screen inspector's helper, one welder (gas and arc), one welder's helper, two mechanics, two mechanic's helpers, one oiler (using a pressure gun), one clean-up man, one motor blower to blow dust out of motors and inspect oil in motors and speed reducers, and one garage mechanic (maintaining the motor trucks which haul reject). Two other men spend 5½ hours on maintenance and the remainder on operation. Completing the preparation-plant maintenance force list are eight other men, four men on each operating shift, as follows: one mechanic, who checks the plant and makes a report to the master mechanic; one machinist, who does most of his work in the shop but spends his time on preparation-plant parts; and two oilers.

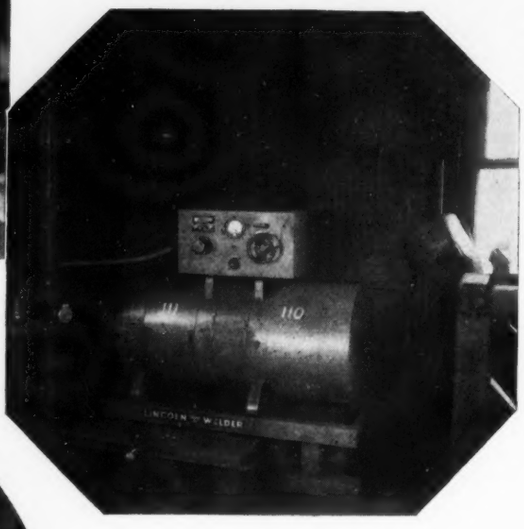
Fig. 1—Regular reports facilitate maintenance

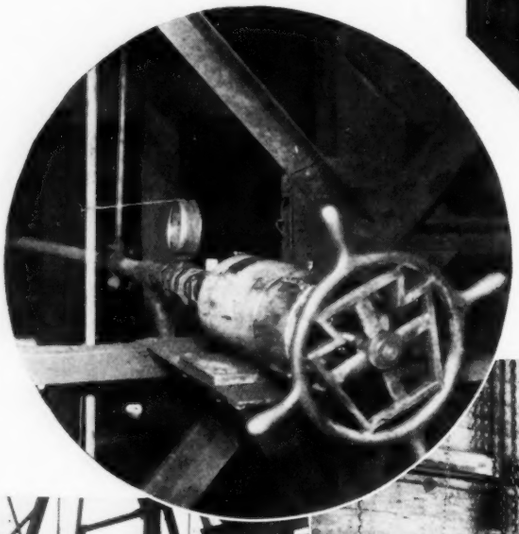




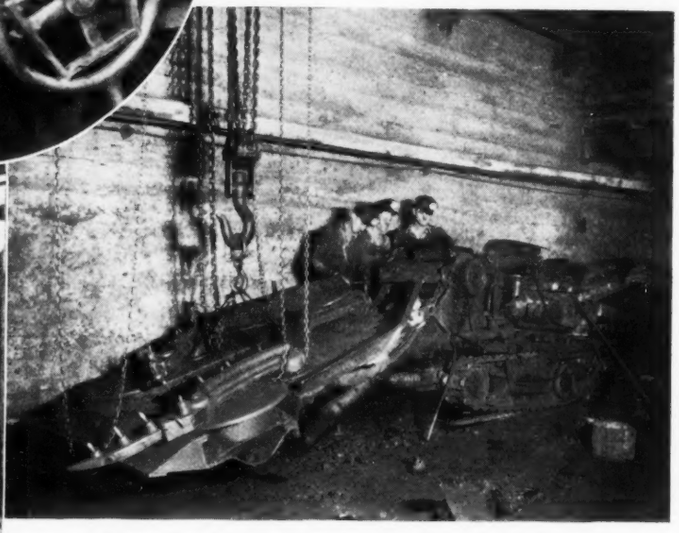
Building a loading machine head by arc-welding in the corner of the surface shop at Zeigler No. 2

This 400-amp. arc-welder, with leads to all parts of the building, stands ready for instant call in the central preparation plant at Zeigler





Low cost and adequate lubrication of shaker eccentrics of shaker chutes in the central preparation plant are assured by this pressure lubricator



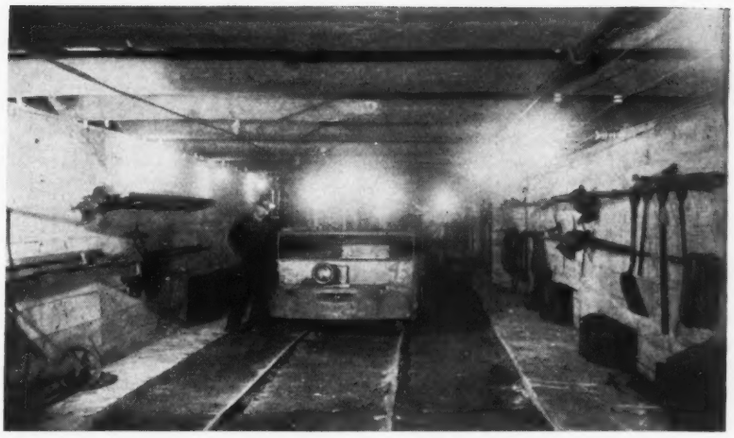
Removing the head from a loading machine in the shop on the main bottom, Zeigler No. 2 mine. This shop is principally a place for assembly. Units or parts are repaired in a shop on the surface

Hoisting or lowering equipment in a shaft is a job for the chief electrician's maintenance crew. Here, at Zeigler No. 1, is the final step in bringing an air-shooting compressor up the materials shaft

All renewals of conveyor troughs and perforated screen plates are made with Ryerson abrasive resisting steel, which lasts four to five times as long as plain steel. This same steel is used in building heads and in conveyor repairs for Joy loading machines. Systematic methods, such as have been adopted by large industrial plants, are followed in the preparation plant. The superintendent has a data book in which are recorded the dates of all screen changes and the screen service life, dates of pump-part renewals and life, and dates and information concerning gaging of air gaps, oil changes and bearing changes for the 94 electric motors which drive the plant.

He also maintains, separately from the general storehouse inventory, a detailed perpetual inventory of all repair parts and supplies on hand for the plant. The object is to take every possible precaution against a plant shutdown due to lack of some necessary item of material the need for which can be foreseen. For convenience and speed in arranging for arc-welding at any point in the plant a 400-amp. Lincoln arc-welder is permanently installed on the second floor, with heavy cable to a large number of attachment outlets.

In Zeigler No. 2 mine the maintenance crew on underground equipment, under the chief electrician, numbers 43 men, with duties substantially as at No. 1 mine (Table III). Prior to August, 1935, when hand loading prevailed, the crew numbered 24. No. 2 mine locomotives, mining machines and loaders are completely rebuilt periodically but the interval varies somewhat in accordance with what extra work the standard crew may be called upon to do.



In Zeigler No. 1 mine two men on each of three shifts grease, inspect and repair locomotives.

Production delays by reason of equipment failures are reported each day by the loading-machine foremen. After summarizing these, a clerk sends copies to the section foremen, mine manager, superintendent and chief electrician. For some time after loading machines were installed a monthly delay report was made, but after the most outsanding delays were eliminated this report was discontinued.

On locomotives, cutters and loaders, Tirex rubber-sheathed cable is used exclusively—No. 2 single on locomotives, No. 2 concentric on cutters and No. 2 twin parallel on loaders. All trailing cables are protected by fused nips fitted with No. 12 bare copper-wire links, fusing at approximately 235 amp. Bare No. 18 copper, fusing at 83 amp., is used on drill-cord nips. Asbestos-insulated wire and cable is used on all equipment subjected to heat. All motor cases on locomotives, mining machines and Joy loaders, for example, are wired with Rockbestos.

Ropes in the main shaft at No. 2 usually hoist about 180,000 tons before they must be renewed. Roebling 1½-in. 6x19 "Blue Center" ropes are now being used on this 345-ft. lift, where the duty is severe because of the rapid acceleration and high speed. Mine cars are hoisted on self-dumping cages and the hoist consists of a pair of 28x42-in. engines driving a 10-ft. cylindrical drum. To start the hoist the engineer jerks the throttle wide open. When he closes it at the end of 7 seconds to effect a 5-second slow down and dump entrance, the rope speed is 3,292 f.p.m. Combined weight of a cage (11½ tons) and a loaded car (5.7 tons) is 17.2 tons.

At No. 2 the top foreman also is the master mechanic and is in charge of the shop as well as the power plant, lamp house, sand drying plant and timber and material yard, where eight men are employed. His shop force consists of three machinists, one welder, four men on cage repairing and rebuilding and general structural work, two blacksmiths, two blacksmith's helpers and nine men repairing mine cars. Cages are built complete at the mine and the total life is about one year. After an initial service of approximately six months, a cage is taken out of the shaft and rebuilt. After another service period of about the same length it is junked.

One duty of the blacksmiths is to provide links for use with purchased hitchings for mine-car couplings. These links are made from 1⅛-in.

Table III—Constitution of Chief Electrician's 42-Man Maintenance Crew for Underground Machinery, Zeigler No. 1 Mine

Classification	Number	Duties
Mechanics	2	Work day shift in top shop but are confined to repairing and rebuilding electrical and mechanical equipment used underground. Unit assemblies of loading machines taken out to this shop for rebuilding. All other men of the chief electrician's crew work underground.
Welders	2	
Section repairmen	5	One in each of the five loading-machine sections during the day shift. Available for call in case of trouble on locomotives, mining machines, drills and loading machines.
Mechanics	5	Work night shifts in pairs of one mechanic and one helper to each of the five loading-machine sections. Duties to grease and repair loading machines.
Helpers	5	
Motor-generator operators	5	These men, stationed at the underground d. c. substations, work day shift and have the additional duties of grinding drill and mining-machine bits, making room-track bonds and filling oil guns.
Loading-machine repairmen	2	Work in loading-machine repair shop on main bottom; assembling principally.
Mining-machine repairmen	2	Work in machine-repair shop on main bottom; repairing and rebuilding.
Locomotive repairmen	6	Work in locomotive-repair shop on main bottom (two men on each of three shifts).
Bondmen	2	Apply arc-weld track bonds.
Wiremen	2	Hang trolley wire.
Feeder men	2	Install feeder cables (on that job only when needed).
Armature winder	1	Works in electric shop on main bottom.
Electrician	1	Inspects and repairs motor-generators, pumps, telephones, signals, feeders and miscellaneous electrical equipment.

steel rod cut with beveled ends to give a 60-deg. opening when bent to shape. The opening then is closed by arc-welding. A maintenance practice common to both Zeigler mines is the use of Tool Steel Gear & Pinion Co. gears and pinions on locomotives, mining machines and loading machines.

Centralia No. 5 mine, a shaft operation producing 1,900 tons per 7-hour shift, is operated as an entirely separate unit which, together with a smaller capacity, is responsible for it being maintained by methods somewhat different from those at the Zeigler mines. Seven Type 5BU loaders, of which one is a spare, went into operation in 1927 and have the original Type 30K Crocker-Wheeler motors with Rollway roller bearings. Car changing is done with Goodman single-motor cable-reel ("humpie") locomotives.

Practically all shop work is performed on the main bottom and the underground shop is equipped with a 150-amp. Lincoln welder. In this mine, worn tires on all locomotives are replaced with new ones instead of arc-welding. Renewal gears for the most part are bought from the manufacturer of the equipment but some special Tool Steel gears are purchased.

Until recently standard chains and bits were used exclusively on the cutter equipment (six Goodman 12AA machines with 8½-ft. bars) and the bits were sharpened in a Sullivan roller and hard-surfaced with Haynes Stellite. Now, Cincinnati "Duplex" chains and bits are employed. For hard-surfacing Joy clutches and wearing strips, Stoodite is used because of a slightly lower cost and because it can be applied by arc- as well as gas-welding. Shortwall mining machine bodies and motor cases of main and swing locomotives are rewired with Rockbestos heat- and oil-resisting cable when the units are given a general overhaul. All armature winding is done in a commercial shop.

Braid- or cord-covered trailing cables (No. 3 size) are used on service locomotives and on mining machines, with rubber-sheathed cables on Joy loaders (No. 4) and coal drills (No. 12). Rope renewals at the main shaft (coal, men and materials) are made about once a year, or after approximately 300,000 tons of coal has been hoisted. The ropes are 1¼-in. and the hoist is steam-operated. Total hoisting distance is 600 ft. and the rope lengths, as originally installed, are 820 and 840 ft. respectively. Lubrication applied to these ropes is a special E. C. Mullen dressing.

Maintenance of machinery at the Crescent Nos. 1 and 6 mines of the Crescent Mining Co., near Peoria, heads up at a roomy, well-lighted modernly-equipped central shop and warehouse at No. 6 mine. A chief electrician supervises the maintenance of practically all underground machinery at the two mines and a master mechanic, who spends most of his time as foreman of the machine shop, also has charge of the maintenance of tipples as well as the underground dump at the foot of the No. 6 belt slope.

All heavy or extensive repairing and rebuilding, and also all repairs or unit assembly work requiring accurate workmanship, are done in the central shop. At No. 6 mine the cutting-machine equipment includes a spare which is kept "rotating"—that is, kept ready for duty in place of any other machine which may require extensive repairs. So far as possible, however, the periodic general overhauls of equipment are made during the slack-run summer months.

All armature winding for the two mines is done in the No. 6 shop. When mining-machine and locomotive motors are overhauled, the wiring inside of cases is renewed with Rockbestos. Maintenance of d.c. pump motors, which was a troublesome item at the two mines, is being reduced by a modernization program working toward replacing all small d.c. reciprocating pumps with fewer units of the a.c. centrifugal type. Tire work and bit sharpening are also concentrated at the central shop. Filling of tires is done with a Westinghouse automatic head and the locomotives so served are in main-line and swing duties, as the gathering is done with mules in both mines. Mining-machine bits are repointed with a Sullivan roller sharpener and in No. 6 mine are used without special treatment. In No. 1 mine a one-year test is being conducted on hard-surfacing and the bits for this mine are now being plated with Borod.

Heavy and extensive repairs and work requiring more than ordinary accuracy at the two Crescent mines are done in this well-equipped central shop adjoining the warehouse at No. 6

Table IV—Averages of Electrical Department Expenses at the Two Zeigler Mines, Both Operating 100 Per Cent Mechanical *

	Cost per Ton					
	March, 1937			February, 1937		
	Labor	Supplies†	Total	Labor	Supplies†	Total
Maintenance of loading machines	$0.0220	$0.0189	$0.0409	$0.0214	$0.0299	$0.0513
Maintenance of cutting machines	0.0032	0.0085	0.0117	0.0036	0.0072	0.0108
Maintenance of main-line locomotives	0.0019	0.0012	0.0031	0.0022	0.0061	0.0083
Maintenance of relay and service locomotives	0.0105	0.0099	0.0204	0.0100	0.0106	0.0206
Maintenance and operation of motor-generator sets	0.0058	0.0002	0.0060	0.0057	0.0035	0.0092
Maintenance and installation of trolley wire	0.0057	0.0017	0.0074	0.0025	0.0042	0.0067
Maintenance and installation of feeder	0.0014	0.0007	0.0021	0.0012	0.0230	0.0242
Maintenance and installation of bonds	0.0026	0.0011	0.0037	0.0026	0.0020	0.0046
Maintenance and installation of underground lights	0.0002	0.0011	0.0013	0.0007	0.0012	0.0019
Maintenance and installation of underground phones	0.0002	.....	0.0002	0.0003	0.0006	0.0009

* Includes only underground electrical and mechanical machinery; that is all underground equipment whose maintenance is under supervision of the chief electricians of the mines.
† Including lubricants.

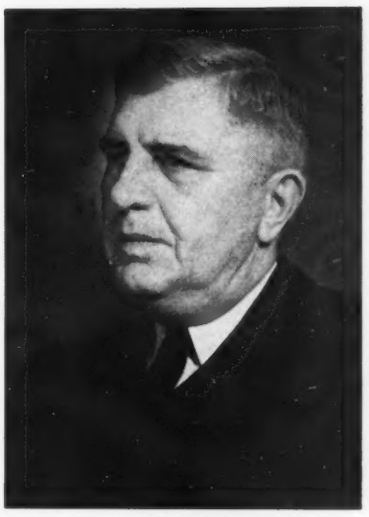
OPERATING PERSONNEL
BELL & ZOLLER MINES

D. R. SCHOOLER
Superintendent, Centralia Coal Co.

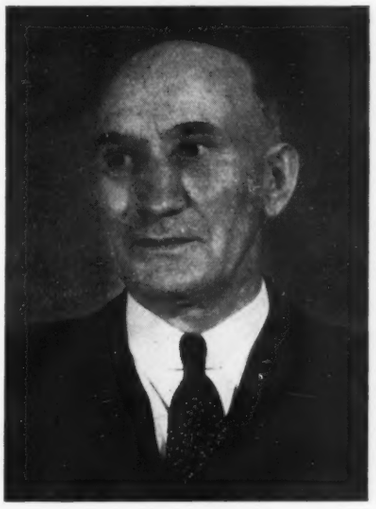
WILLIAM McNAIL
Superintendent
Zeigler preparation plant

R. J. OLDHAM
General Manager, Centralia Coal Co.

NORMAN C. PRUDENT
General Superintendent
Crescent Mining Co.



E. L. BERGER
General Superintendent
Bell & Zoller Coal & Mining Co.



LEE HASKINS
Superintendent, Zeigler No. 1 Mine

DALE CARTER
Superintendent, Zeigler No. 2 Mine

Timber yard at Zeigler No. 2 mine. Separate timber yards are maintained at each mine but the stocks are under control of the central warehouse

SUPPLY SERVICE

+ Bell & Zoller Mines

TO ACCUMULATE a stock of supplies and repair parts to meet the normal demands of operation requires only an outlay of money but to maintain that stock in "quick-reach" order without allowing an accumulation of dead items, and to hold all active items to the smallest quantities consistent with efficient operation, require systematic methods, which are less difficult to attain if the work is centralized. This centralization has the inherent advantage of a diversity factor that reduces total stock requirements. Of the three divisions of Bell & Zoller mines, the purchases for all of which are handled by a purchasing agent in the Chicago office, the Zeigler and Crescent operations have central warehouses. The Zeigler unit effected a saving of approximately $30,000 in supplies purchased during the first six months after its establishment in June, 1936.

Prior to that time separate warehouses had been maintained at both Zeigler mines, which are not over two miles apart. One of the reasons for two warehouses was the worthy consideration of keeping both mines separate so that the officials at neither could offer as an "alibi' something out of their control. Mechanization of Zeigler No. 2 mine in August, 1935, and starting one of the world's largest mechanical cleaning and screening plants at the same mine a few months later, which greatly increased the number of spare parts that had to be stocked, brought the decision to establish at No. 2 mine the central warehouse for both Zeigler operations.

When this centralization took place all dead stock was eliminated from the accumulations in both the old warehouses. For the new warehouse there was available a ground-level basement and a first floor in a 50x75-ft. end of the power-plant engine room. An electric elevator connects the two, but in so far as possible only items of small size and medium to light weight are kept on the upper floor, where there is a partitioned office for the general storekeeper and his help.

The graph indicates the degree to which total purchases and total charged-out invoices dropped when the central warehouse was established, although the total stock on hand was increasing because of more equipment and more effective coverage of needs. The breaks in the graphs beginning in April, 1936,

Table 1—Gas-weld and Arc-weld Rods Stocked at Zeigler Central Warehouse

Description	Diameters Carried, Ins.
Type W-20 G.E. electrodes	1/8, 5/32, 1/4, 5/32
Lincoln Toolweld rods	1/8, 5/32
Page 7 BC coated electrodes	1/8, 5/32, 5/32
Page F electrodes	5/32, 5/32
No. 4 Erico electrodes	5/32
Coated copper electrodes	1/4
No. 1 H.T. St. Mod welding rod	1/16
No. 4 H.T. St. Mod. welding rods	1/8, 3/16, 1/4
No. 25M bronze rods	1/8, 3/16, 1/4
No. 9 cast-iron rods	1/4, 3/8
Haynes Stellite rod	5/32
No. 23 aluminum welding rod	1/4
Borod	3/8
No. 24 Lindeweld rod	3/16, 1/4
No. 6 C.M. welding rod	1/4
No. 1300 alloy rod	3/8

are due to mine shutdowns for repairs and improvements.

Perpetual inventories are maintained in "Shif-Dex" visible record binders, which system supplanted the old loose-card-in-drawer systems of the displaced individual warehouses. Those latter systems had the disadvantages that cards might be lost or mixed out of order and were slower to handle. On the "Shif-Dex" cards are posted quantity, unit price, invoice price, bin number, section number and purchase-order number. Small quick-detachable tabs are used to indicate material on order.

Control Includes Mine Stocks

Mine timbers and building materials, including cement, are stocked at the individual mines because of available storage space and lower cost of handling, but all items are under control of the central warehouse. Supplies stocked in the underground repair shops to meet regular and emergency needs are charged out to the mine when they leave the central warehouse and then are under control of the chief electricians. Truck drivers who deliver materials to No. 1 mine report to the top foreman at No. 2 mine, where the central warehouse is located.

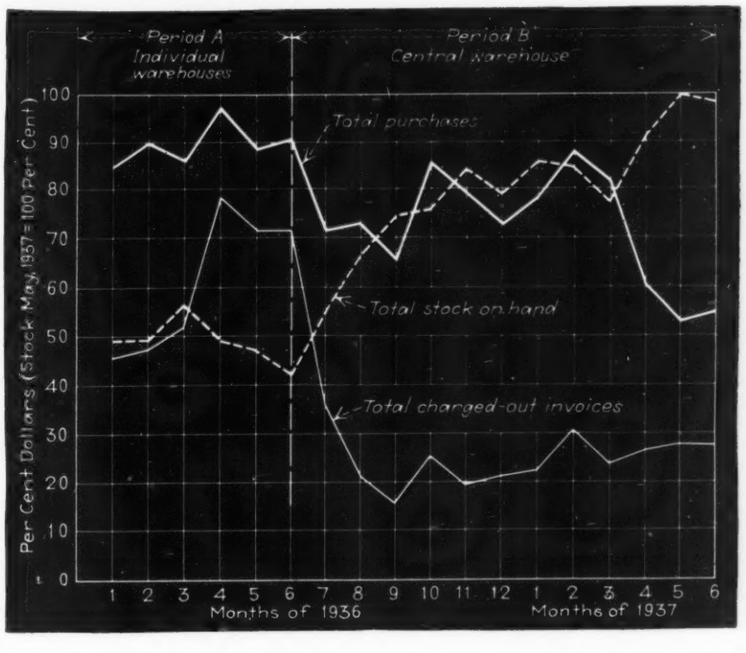
Formerly, requisitions were made once a month, but now these memorandums to the purchasing agent are made whenever material is required. When a mining department needs material which is not regularly stocked, the want is made known with proper signatures on a form which is "a request for the store to place requisition." On any contemplated carload purchase, except for treated timbers, the general storekeeper first requests an "A.F.E." (authority for expenditure), which, by going through the offices of the general manager and vice-president for O.K.'s, affords those executives opportunity to check on carload buying and large expenditures. The purchasing agent keeps the general storekeeper informed as to price trends and it is the responsibility of the latter official to place proper requisitions for supplies for six months or more to protect against rising prices.

Tabs on the perpetual inventory cards indicate material on order

Inauguration of the central warehouse brought costs to an even keel. Before that about 90 per cent of the purchases were charged out directly when the material was received. Rail is now practically the only regular item on which a direct charge is made. Items of non-recurring expenditures are so charged, however.

During 1936, the total inventory

Indicating the savings by warehouse centralization at the Zeigler mines in June, 1936



Supply room adjoining repair shops on the main bottom, Zeigler No. 1 mine. The supplies and repair parts in these bins were charged to operation when sent from the central warehouse

Welding rods and electrodes are kept in steel-pipe receptacles on a caster-mounted bench in the Zeigler central warehouse

Zeigler central warehouse is equipped with steel bins

of stock, including mine timbers, averaged $4.10 per ton of daily mine capacity (single-shift operation), which figure is lower than that at most mines for just the spare-and-repair-parts portion of the mine-warehouse inventory. The total inventory of loading-machine parts was $16,000 (36 loaders, including spares and double-shifted units); locomotive parts, $11,000. At the Zeigler mines, supply items sold to miners are not numerous because closed lights are used and because, both mines being on 100-per-cent mechanical loading, all "shooting" (Cardox and Airdox) is done by company men.

At Crescent No. 6 mine a 40x40-ft. partitioned space in a modern steel building, which also houses a central shop, serves as the central warehouse for that mine and also for Crescent No. 1, 1½ miles distant. Here the stock inventory runs less than $20,000. This warehouse and the sale of supplies to miners over a counter is in charge of a stock clerk. Over-counter sales involve principally safety shoes, hats, goggles, carbide. soap, fuse, miners' hand tools, gloves, carbide lamps and lamp repairs.

Regular Inventories Taken

Another duty of this clerk is first aid, which is administered in a space adjoining the warehouse office. With numbered steel bins for materials and a perpetual card inventory the arrangement and systematic procedure of this warehouse would do credit to many operations which handle a much greater quantity of material. Every six months a complete physical inventory is made, but, whenever time permits, physical inventories of certain sections are taken in order to discover discrepancies arising from faulty charging, due to the necessity of allowing night repairmen access to parts.

Warehouse practice at the Centralia No. 5 mine is much the same as at the Crescent division except that the space is in an old brick building fitted with wood bins and shelves. Nevertheless, the material is kept in exact order by a stock clerk, who also sells supplies to the miners. From this mine, requisitions for stock materials are sent to the purchasing department on the 25th of each month, with the understanding that purchases will be shipped any time after the first of the next month. Oil, powder, rails and treated ties are purchased in carload lots and before requisitions are made for these an A.F.E. for each purchase is secured.

MERCHANDISING

+ Bell & Zoller Coals

WHEN the economic dreamers achieve that Utopian state where demand is in perfect balance with supply, then, and then only, perhaps the prospective buyer may beat a path through the woods to seek out the maker of the "better mousetrap." But producers in today's competitive markets who sit waiting for such customers incur no risk of acquiring calloused hands from handling orders. All the bush beating and trail breaking must be done by the sellers—and done intelligently, too, if their labors are to be well rewarded.

Because of their geographic location, Illinois coal producers must sell their output in some of the most highly competitive markets of the country. Freight-rate structure and the westward pressure of Appalachian coals throw up an effective barrier against eastward movement. In the general industrial market of the Middle West, where normally transportation charges limit the influx of Eastern coals, Illinois must battle for steam-coal business with Indiana, western Kentucky and in many States west of the Mississippi River with coals produced locally.

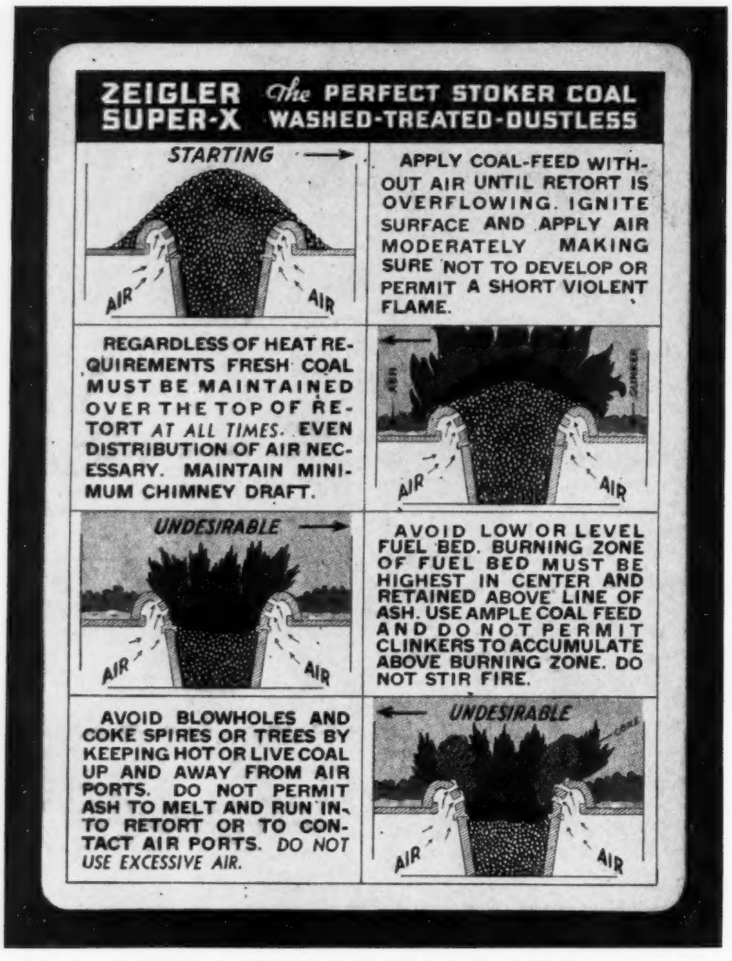
The Middle West and the Northwest offer rich domestic markets for bituminous coal. Except where the household stoker has entered the picture, the domestic demand is concentrated in the larger sizes. Many Illinois coals are in a favorable position to meet this demand because their physical structure gives a relatively high yield of prepared sizes.

Enjoyment of this advantage, however, is not without its penalties. High yields of prepared sizes compel producers mining such coals to cultivate the markets open to these sizes much more intensively. Since a large part of this tonnage is bought from the mines for resale to household consumers, this cultivation involves building up a great number of retail outlets and holding their patronage by merchandising service and counsel as well as by delivering a product adapted to the market area covered by each individual retail coal merchant. Moreover, the very attractiveness of the domestic market invites competition not only from adjacent mines and contiguous coal-producing States but also from the Appalachian region.

Although occasional shipments may be made to other destinations, distance and competition limit the general movement of Illinois coal to markets within the State itself, Iowa, Minnesota, Missouri, Wisconsin and parts of the Dakotas, Kansas and Nebraska. This is the area, says Walter H. Voskuil, mineral economist, Illinois State Geological Survey, "that is logically and economically served by Illinois coal." But, as indicated in the preceding paragraphs, this area is by no means closed territory to competing fields and fuels. All-rail shipments into this area last year approximated 49,250,000 tons; Illinois' share of this business was slightly more than 52.6 per cent. These figures, which include both domestic and industrial tonnages, are exclusive of all railroad fuel, of local production in Iowa, Kansas, Missouri and North Dakota and of the millions of tons to the Northwest via the docks.

This, in brief, is the marketing picture which faces the sales organization of the Bell & Zoller Coal Co. after its operating subsidiaries have done their job of mining, cleaning and sizing the coal to meet the varying but exacting demands and specifications of consumers ranging from the finicky customer of the retail dealer who wants a dustproof product to the large industrial buyers, public utilities and railroads that demand both quality and a competitive price. Every day the five mines run the sales department must find markets for more than 20,000 tons. Only one organization in the

Dealer signs stress Bell & Zoller theme


ZEIGLER SUPER-X
The PERFECT STOKER COAL
WASHED-TREATED-DUSTLESS
STARTING
AIR
AIR
APPLY COAL-FEED WITHOUT AIR UNTIL RETORT IS OVERFLOWING. IGNITE SURFACE AND APPLY AIR MODERATELY MAKING SURE NOT TO DEVELOP OR PERMIT A SHORT VIOLENT FLAME.
REGARDLESS OF HEAT REQUIREMENTS FRESH COAL MUST BE MAINTAINED OVER THE TOP OF RETORT AT ALL TIMES. EVEN DISTRIBUTION OF AIR NECESSARY. MAINTAIN MINIMUM CHIMNEY DRAFT.
AIR
AIR
UNDESIRABLE
AIR
AIR
AVOID LOW OR LEVEL FUEL BED. BURNING ZONE OF FUEL BED MUST BE HIGHEST IN CENTER AND RETAINED ABOVE LINE OF ASH. USE AMPLE COAL FEED AND DO NOT PERMIT CLINKERS TO ACCUMULATE ABOVE BURNING ZONE. DO NOT STIR FIRE.
AVOID BLOWHOLES AND COKE SPIRES OR TREES BY KEEPING HOT OR LIVE COAL UP AND AWAY FROM AIR PORTS. DO NOT PERMIT ASH TO MELT AND RUN INTO RETORT OR TO CONTACT AIR PORTS. DO NOT USE EXCESSIVE AIR.
UNDESIRABLE
AIR
AIR

A firing card helps promote stoker-coal satisfaction

State had a greater output in 1936 and that company was drawing upon the tonnage of fourteen mines.

Bell & Zoller coals find their major markets in Illinois, northern Indiana, Iowa, southern Minnesota, Missouri, Nebraska, South Dakota and Wisconsin. Some tonnage also moves into Arkansas, Kansas, North Dakota and Tennessee, but the volume shipped to those States is not large. During the British strike of 1926, six cargoes of Zeigler coal went to European ports. In addition to coal from its own mines the company also handles coal from the Paris, Spadra and Excelsior fields in Arkansas; from the Wilmington and Springfield district in Illinois, and from Colorado, Wyoming, Kansas, eastern Kentucky and West Virginia. Approximately 50 per cent of the output goes into domestic channels and the other half into industrial markets.

Sales headquarters are in Chicago, with branch offices at St. Louis, Mo.; Omaha, Neb.; Minneapolis, Minn.; and Pekin, Ill. Inclusive of the general sales manager, director of sales promotion and branch-office managers, the present sales personnel totals 35. Three members of the sales force are combustion engineers. Originally they were employed with the idea that they would work primarily on industrial accounts, but a large part of their time now is spent in helping retail distributors of Bell & Zoller coal solve combustion problems and handle knotty complaints from householders.

No avenue of legitimate and effective promotion is overlooked by the sales department in merchandising the domestic sizes. Booklets which reflect credit on the printing arts, attention-compelling smaller pieces for mailing by the retail distributor to his customers, attractive and useful novelties for distribution to householders, suggested newspaper advertisements for the retail merchant and copy in the trade publications reaching that group are among the mediums employed.

Unlike some producers, however, Bell & Zoller issues no annual promotional folder of retail advertisements and direct mailing pieces. Instead, it relies upon a succession of suggestions and promotional material keyed to what seem to be the requirements of the changing marketing picture. But these are sent out with sufficient frequency to keep the retailer interested both in the particular message and in the manner of its presentation.

One of the most successful promotion ventures has been the talking movie of the mining and preparation of Zeigler coal. The script is informative without the excessive "plugging" of the product which defeats the purpose of some advertising ventures of this nature and so many radio programs. From a photographic standpoint, this picture rates high. Not the least interesting feature is the simulation of the prehistoric swamp forests in the opening shots. Prints of the movie dubbed for sound are lent to retailers for exhibition at their local picture theaters and before women's clubs and other social or business group gatherings in their community.

No regular promotional campaign to reach industrial consumers is carried on. Some of the literature put out, however, makes a direct appeal to both the industrial and retail groups. A notable example of this dual-purpose material was a striking 24-page $9\frac{3}{4}$x$12\frac{3}{4}$-in. folder entitled "Achievement," sent out to both groups at the end of last year. This booklet told the story of Zeigler coals with special emphasis on the new cleaning plant which went into operation in 1935. Attention also was called to laboratory control and to the shooting methods used to reduce degradation. Adaptability of the coal to general industrial, specialty and domestic uses was stressed. Naturally the advantages of "Superwashed" coal have had a prominent place in all the promotional efforts of the company in recent months.

The advent of the domestic stoker marked a new era in coal merchandising. Always alert to capitalize on changing market trends, the Bell & Zoller company set out to pioneer in the development of a coal specially prepared for use in household automatic coal-burning equipment. The problem of producing a coal that would meet the exacting demands of the small stoker was put up to the engineering and advisory staffs of the organization. Counsel, too, was sought from the engineering and sales divisions of the stoker manufacturers as to specification for this coal. Finally, after months of research and experimentation, the new

fuel—"Super-X"—was introduced on the market.

This in itself was a radical departure from established coal-merchandising practices. Here was a coal sold not to conform to any given size specification but rather on the assurance of complete consumer satisfaction. But research did not stop there. After many experiments with various dustproofing materials, it eventually was decided that a thin coating of protective wax would best render the coal permanently dustless in its journey from the mine to the stoker retort. The sharply increasing sales of "Super-X" stoker coal give convincing evidence of consumer acceptance. Residential-type stokers and the advantages of burning "Super-X" coal in such equipment, of course, are prominently featured in the promotional activities of the company.

In common with many other progressive producing organizations, Bell & Zoller has consistently encouraged its retail customers to use advertising space in their local newspapers. Recently, however, the company has been going beyond that and has been advertising directly in the newspapers with copy planned to appeal to the ultimate consumer. Choice of areas for these campaigns has been dictated by competitive conditions and the volume of coal consumption in the areas selected. As yet, this particular kind of advertising is in the experimental stage.

Aside from this experimental newspaper campaign, Bell & Zoller also uses the *Chicago Journal of Commerce* as part of its regular campaign and trade publications such as *Black Diamond, Coal Dealer* and *Coal-Heat*. It has been a consistent advertiser in the annual editions of the *Keystone Coal Buyers' Manual and Directory of Mines*. Many retail coal associations now run exhibits in connection with their annual meetings, and the Bell & Zoller company has displays at all such major gatherings in the territory served by its coals.

Much of the advertising and merchandising in the coal industry is still in a primitive state; indeed, to call some of the promotional efforts advertising is to stretch courtesy. But the Bell & Zoller organization has acted on the theory that a good product should be well advertised; the character of its promotional literature is not only outstanding in coal but can hold its own in the broader field of industrial advertising as a whole.

Examples of Bell & Zoller promotion pieces

EXIDE-IRONCLAD

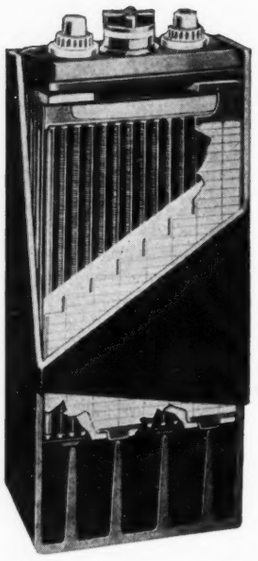
. . . . the battery that speeds up underground haulage and cuts costs

THE first thing needed in a battery for underground haulage is *power.* An abundance of power is one of the features that have made the Exide-Ironclad Battery famous wherever loads are heavy and service is tough.

To maintain production under today's conditions, haulage speeds must be maintained throughout the day, so that the last load moves as fast as the first. That's another characteristic of the Exide-Ironclad Battery, for it maintains a good voltage all day long.

For economy, the battery must be tough and rugged, able to take years of hard usage—and here the Exide-Ironclad is outstanding. Reports from users in all parts of the country indicate that these batteries are delivering far longer life than most operators anticipate — life that is trouble-free and economical from beginning to end.

Write today for free booklet, "The Storage Battery Locomotive for Underground Haulage."



Cut-away view of Exide-Ironclad cell, showing the unique positive-plate construction. Slotted rubber tubes retain the active material while exposing it freely to the electrolyte. One of the reasons for this battery's dependable performance and long life.

Exide
IRONCLAD
BATTERIES
With Exide **MIPOR** Separators
"MIPOR," Reg. U. S. Pat. Off.

THE ELECTRIC STORAGE BATTERY COMPANY, Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

OPERATING IDEAS

From Production, Electrical and Mechanical Men

Many Tasks Carried On By Substation Men

"Blowing the whistle" is one of six duties of the underground substation operators in the two Zeigler (Ill.) mines of the Bell & Zoller Coal & Mining Co., and for that reason expense has not been incurred to change the a.c. substation controls from manual to automatic type. Feeders leaving the substations, however, are equipped with automatic reclosing circuit breakers. In these two mines, both together producing by mobile loaders nearly 13,000 tons per day of one shift, the substations are placed close to the sections served. Voltage at the ends of the wires is maintained at 250 or above during normal maximum loads.

At both mines electric power is generated at plants operating in connection with steam hoists. These plants each contain one large motor-generator unit which supplies the main bottom and near-by hauls and is tied to the other substations by 6/0 trolley lines and 1,000,000-circ.mil feeders.

Since all men in the mines are on day rates, importance is attached to signaling starting and quitting times and to signaling the starting of man-trips, in conformity with the joint contract requiring man-trips to delay starting until ten minutes after quitting time. For the underground this signaling takes the form of blinking the lights by cutting off all d.c. power for three quick successive periods of about one second each. Signals are given by the engineer in the power plant according to exact whistle time.

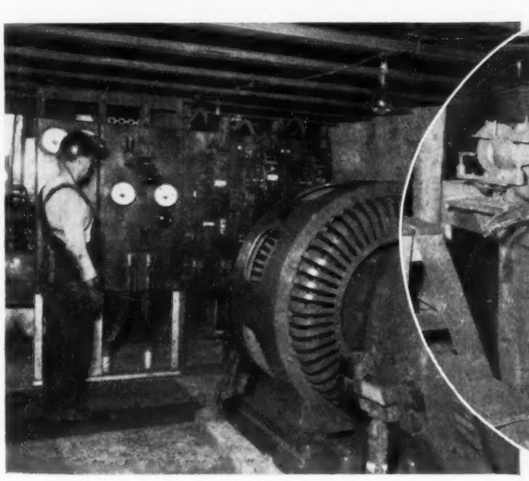
This cutting off of all d.c. power is done by opening the manual breaker in the feeder between the power-plant motor-generator and the mine. Obviously, then, all other motor-generators in the mine must be cut off the underground d.c. distribution system before the signal can be given. Substation operators are required to have watches that are at least fairly accurate, and it is their duty to cut the substations off the system 30 to 60 seconds before whistle time. Machinery operators note the drop in voltage and shut off. In a few seconds three blinks of all lights, as timed and executed from the power plant, proclaim quitting time.

In the lunch period the substation operators are sent a signal of three blinks five minutes before starting time as a reminder to start the motor-generators, but these machines are not put onto the line until after the three blinks that proclaim starting time. At the end of the shift the inside substations are all shut down and the man-trips come out on current from the power-plant substation. Three blinks ten minutes after quitting time signal permission for the man-trips to start for the main bottom. Underground substations are not operated on the two off-shifts unless full power is needed for some special job.

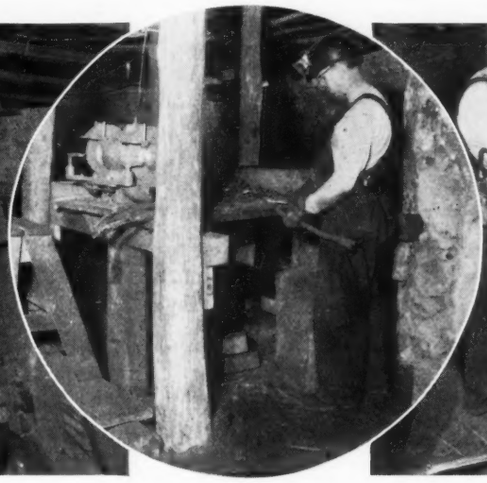
Grinding bits for mining machines and for the mole-foot augers used in drilling, making room bonds and filling oil guns for section greasing crews working on night shift are the other duties of the substation operators.

Grinding and bond making are done at a work bench close to the substation. Cutting-machine bits, which are of the hard-surfaced type, are first sorted by the substation operator into two batches, those to go outside for retipping and resurfacing and those to be touched up by grinding at the substation and put back into service. Approximately 60 per cent are sorted out for regrinding.

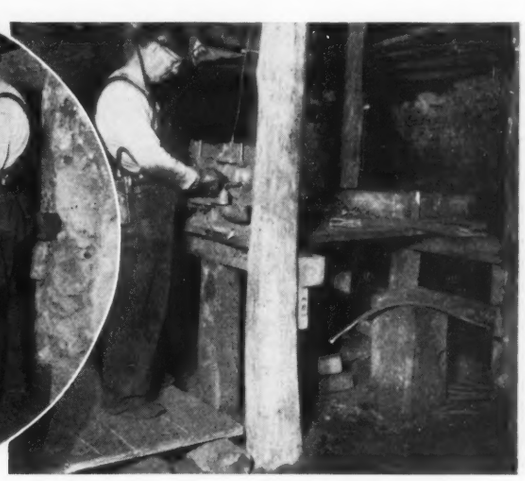
Bond making consists of cutting 26-in. lengths of scrap No. 2 trailing cables,



This operator is starting the m.g. set after receiving a three-blink reminder five minutes before starting time. He will not close the d.c. breaker until after the starting-time signal comes from the power house.



Substation operator making room bonds from scrap trailing cable.



Grinding drill and cutting-machine bits is another duty of the substation operators at the Zeigler Nos. 1 and 2 mines, who also start d.c. conversion sets and manufacture track bonds for room use.

Three seconds to go before tripping the power-house breaker, which will signal quitting time to all men working underground in Zeigler No. 2 mine.

skinning the insulation from the ends, placing two of the cables in parallel and swaging onto each end a steel splicer. These bonds are applied to the room tracks by steel arc-welding, and but one of the two rails is bonded.

Slide Gate in Loading Boom Aids in Changing Cars

To facilitate changing railroad cars at the Zeigler preparation plant of the Bell & Zoller Coal & Mining Co., Zeigler, Ill., slide gates are installed in the bottoms of the top runs of the loading booms a short distance back from the discharge ends. When these slide gates are open, the coal falls through the bottom run of each loading boom into the empty car as it is being moved into position. After the car is in position, normal loading over the end of the boom is resumed by closing the slide gate.

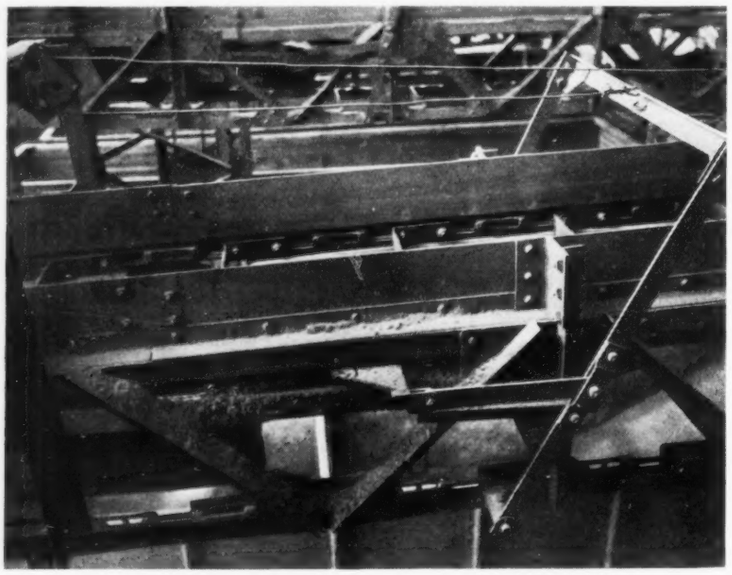
The accompanying illustration shows a slide gate in open position. Opening and closing of the slide gates is controlled from the loading supervisors' booths by means of pull wires attached to pivoted yokes on the booms. By pulling on one wire, the yoke is drawn back, opening the gate. To close the gate, the other wire, which passes over a pulley (see illustration), is pulled in the same manner. Ease of operation is a major advantage of the Zeigler adaptation of this slide-gate principle.

Timbers Removed Safely From Remote Point

In knocking props at the Crescent Nos. 1 and 6 mines of the Crescent Mining Co., operating on LaMarsh Creek, near Peoria, Ill., regulations require that another prop with cap piece be first set. In recovering props, post pullers, jacks and chains or other means of applying power from a remote point must be used. Some rail crossbars are installed on panel entries, and in recovering these a modification of the remote method is used. Using a brace and bit, a hole is drilled in one of the timber legs, in which a dynamite cap is placed. A chain is attached to the crossbar, after which the cap is fired, bringing down the bar, which can be pulled out by the chain. Under very bad top, two men have recovered 80 bars in one shift by this method.

"Hot Hooks" With Own Fuses Replace Machine Fuses

When fused "hot hooks" (nips) were adopted for the trailing cables of Jeffrey 35-hp. Type 35B and 50-hp. 35 BB cutters in Zeigler No. 2 mine, Bell & Zoller Coal & Mining Co., Zeigler, Ill., experience indicated that a fuse on the machine itself was no longer necessary. Consequently the original fuses have been eliminated on all machines, as indicated by the empty box, *C*, of Fig. 2. The hot hook itself, *A*, is strong and simple in design and is assembled in the mine shop.



Slide gate in open position, showing yoke and pull wires

B. & Z. Firsts

• Following out the theme of this issue, the Seventeenth Annual Model Mining Number of Coal Age, the Operating Ideas department this month is devoted to cost-saving and efficiency-promoting ideas developed by operating, mechanical, electrical and safety men at mines in the Bell & Zoller group in Illinois. These selected items will repay study and perhaps will offer a solution or suggest a new approach to some problem of your own. Next month, these pages again will be open to all, so if you have an idea that has saved you money or gotten you out of a difficulty, send it in, with a sketch or photo if it will help to make it clearer. Perhaps you can help another man faced with the same problem. For each acceptable idea, Coal Age will pay $5 or more.

★ ★

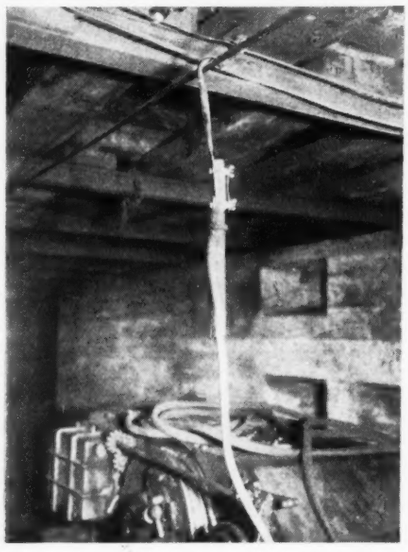
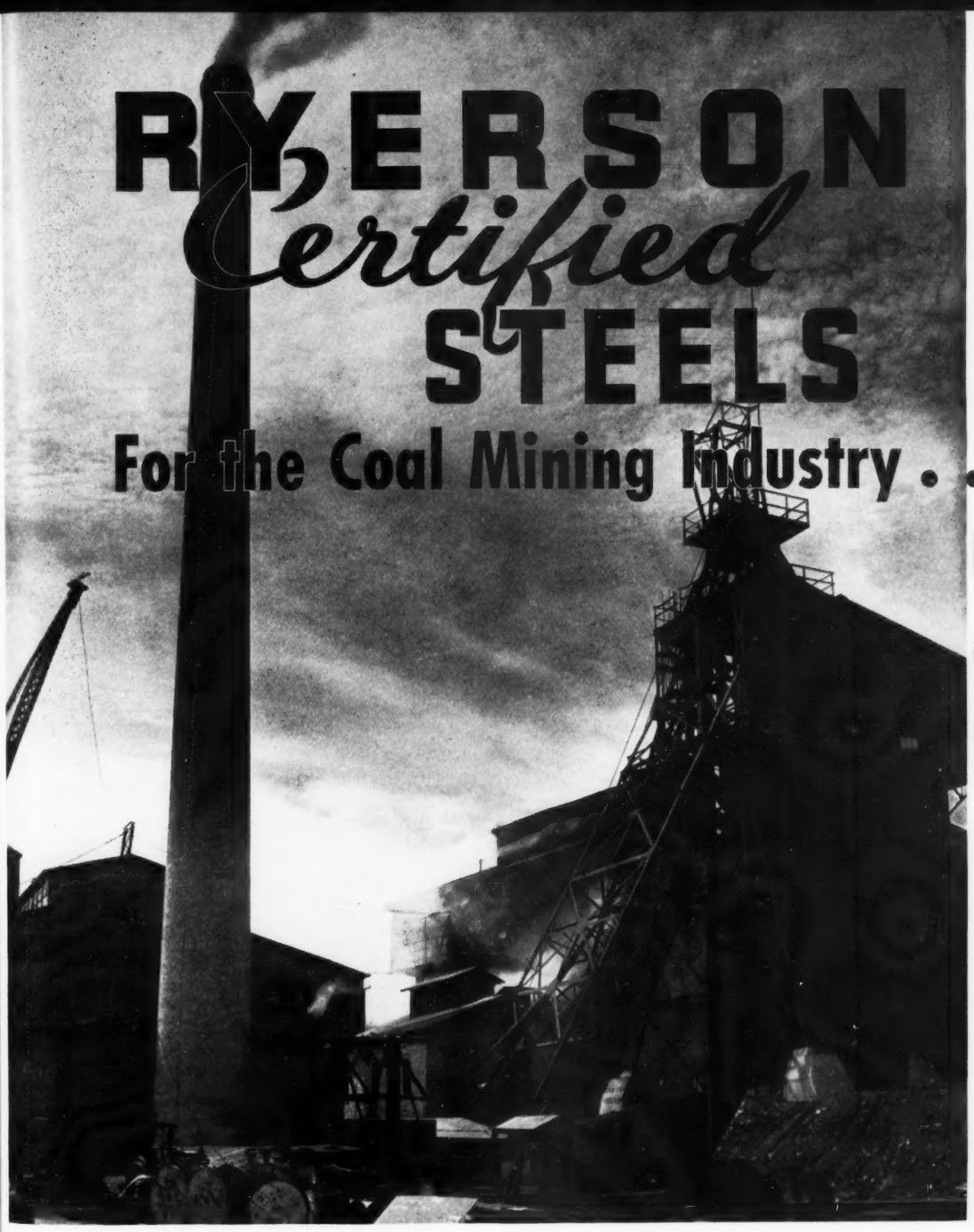


Fig. 1—An asbestos wood block forms the non-combustible base for the open fuse mounting.

To provide a means of quickly disconnecting the machine cable from the truck the Miller connector, *B*, was added on all machines.

The block on which the "hot-hook" fuse terminals are mounted is a 1x1x4½-in. piece of asbestos wood (Fig. 1). The bolts fitted with the wing nuts are of 5/16-in. brass and are spaced 3 in. apart. The clamp terminal to which the trailing cable is attached is the same as that used in a Jeffrey Type 21A mining-machine controller. A 3/8x1x12-in. stick of wood



RYERSON *Certified* STEELS

For the Coal Mining Industry . . . Many Special Products Developed Especially for Coal Mine Use

Ryerson Certified Steels Include:

- Alloy Steels—Tool Steels
- Heat Treated Alloy Steel Bars
- Stainless Steel
- Hot Rolled Bars—Hoops and Bands
- Cold Finished Shafting and Screw Stock
- Extra Wide Cold Finished Flats
- Beams and Heavy Structurals
- Channels, Angles, Tees and Zees
- Rails, Splices, Spikes, Bolts, etc.
- Plates—Sheets
- Strip Steel, Flat Wire, etc.
- Boiler Tubes and Fittings
- Welding Rod—Mechanical Tubing
- Rivets, Bolts, Nuts, Washers, etc.
- Reinforcing Bars
- Babbitt Metal and Solder

● Ryerson Certified Steels are particularly adapted to coal mine requirements. Ry-arm and Ry-ax were developed especially for armature shafts and mine locomotive axles. Ryerson Abrasion Resisting Sheets and Plates are widely used for shaker screens, loader heads, etc. Ryerson Copper-Alloy Plates help combat corrosion.

All Ryerson Certified Steels have outstanding features. They represent the highest quality obtainable in each class of material. Whether you need steel for new construction, equipment modification, current maintenance or emergency breakdown, you can depend on Immediate Shipment from a nearby Ryerson plant.

If you do not have the current Ryerson Stock List, we will be glad to send it—also bulletin showing special products for the Coal Mining Industry.

Joseph T. Ryerson & Son, Inc. Plants at: Chicago, Milwaukee, St. Louis, Cincinnati, Detroit, Cleveland, Buffalo, Boston, Philadelphia, Jersey City.

RYERSON STEEL-SERVICE

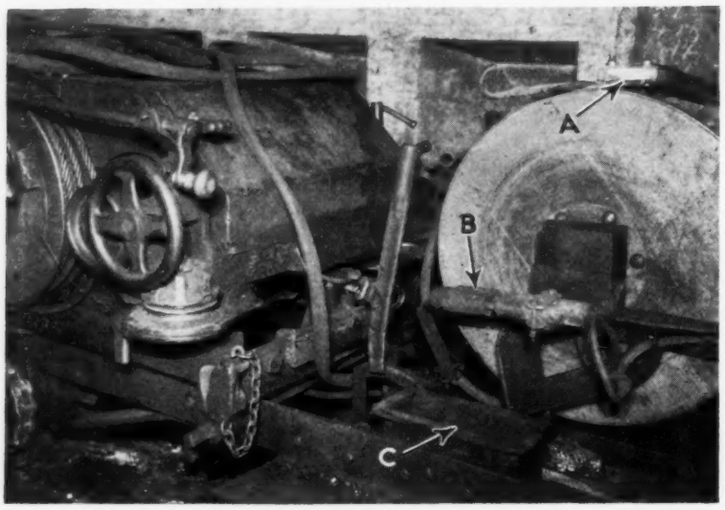


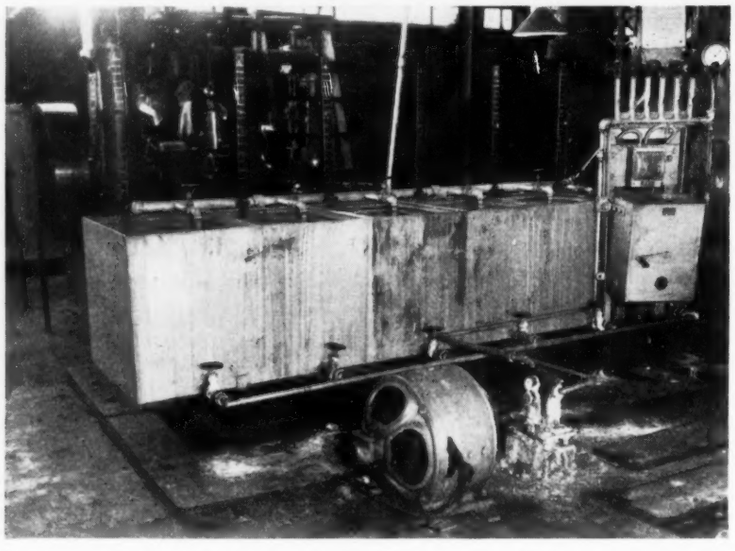
Fig. 2—Fuses displaced on the machines by fused hot hooks on trailing cables were in turn replaced by special connectors.

is taped to the cable to form a stiff handle for the nip. Fuses on the nips of the mining-machine cables consist of No. 12 bare copper wire which will fuse at 235 amp. Those used on nips for coal drills are No. 18 bare copper wire, which size has a fusing rating of 83 amp. The fuses are cut to 4½-in. lengths, put up in small bundles for convenient use.

Pumping Station Facilitates Boiler-Water Treatment

To assure that all-important objective of getting equal quantities of water-treating chemical into all boilers, an improved chemical-pumping system utilizing an oil pump from a Joy 5BU loading machine was installed in the 6,850-kva. power plant at Zeigler (Ill.) No. 2 mine, Bell & Zoller Coal & Mining Co. The steam-raising equipment consists of six 365-hp. Heine straight-tube water-tube boilers, and these same boilers also supply a 28x42-in. coal hoist which operates at maximum acceleration for seven seconds of each hoisting cycle.

Make-up water (plant has jet condensers and spray-pond cooling) comes from a large reservoir, into which surface water flows by natural drainage. This water receives no treatment prior to going into the system. Six rectangular 20-gal. tanks, as shown in the illustration, provide the hand-mixing and storage facilities. In each tank is a float carrying an indicator which registers on a calibrated gage standing in plain sight above the tank. Separate intake lines to the pump suction, and from the pump-discharge manifold to each boiler, all fitted with globe valves, provide for pumping from any tank to any boiler, but each tank, as a rule, serves its individual boiler. At one "shot," or



Tank gages show if each boiler has gotten its ration of chemical. The pump is just to the right of the motor in the foreground.

Maximum and Minimum Variation Which Can Be Expected With the Seasons*

Hardness Soap Test	Grains per Gallon $CaSO_4$	$MgSO_4$	$Ca(HCO_3)_2$
4	3.2	1.0	1.5
12	13.2	1.3	2.0

*Hardness increases with heavy rains and also with long drought.

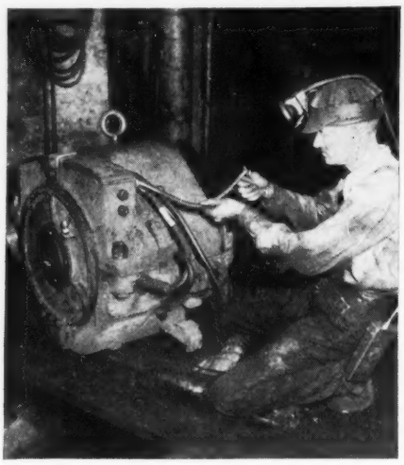
pumping interval, a boiler gets 3 gal. of the chemical solution. Each boiler gets a "shot" every hour during the working shift and every two hours during the night shifts.

Chemicals used in mixing the solution are soda ash (sodium carbonate, Na_2CO_3) and tri-sodium-phosphate ($Na_3Po.12H_20$). The soda ash is added to maintain alkalinity in the boilers. As indicated in the table, the analysis of the raw water from the reservoir varies through a considerable range with the seasons.

Boiler blow-down is continuous through a micrometer-flow control valve and is taken off where maximum concentration occurs, or 6 in. below the low-water line.

Asbestos-Insulated Cables Reduce Machine Delays

With 100-per-cent mechanization, as is the case at the two Zeigler (Ill.) mines of the Bell & Zoller Coal & Mining Co., efficiency does not permit overlooking a single possibility of reducing machinery delays. Some years ago asbestos-insulated cable was tried as a replacement for rubber and braid cables in places on mining



Asbestos cables resist heat deterioration.

machinery where heat, and in some cases oil, is present. It soon proved an unmistakable advantage, so now all motor cases on locomotives, mining machines and loading machines in the two mines are rewired exclusively with asbestos-insulated cables.

The illustration shown caught an electrician in the underground shop at No. 1 mine skinning the ends of the leads of a Jeffrey Type HM64 locomotive motor

American Goggles are "LIFE CHECKS" for EYES... at Crescent No. 1

The most expensive yet most easily preventable of all mine accidents — *eye injuries* — are held to an absolute minimum at Bell & Zoller's Crescent No. 1 Mine.

Here, *all* miners are equipped with American Goggles. And the importance of eye protection is emphasized — called daily to each man's attention — by riveting his life check to the goggle case. Cases are filed in the rack (shown above) at night, picked up in the morning. So every pair of goggles goes down into the mine every day.

According to the U. S. Bureau of Mines, eye injuries cost more than twice as much as any other class of mine accident, — account for the most lost days. Don't tolerate eye injuries on your property. The American Optical Company, through Mine Safety Appliances Company, offers you a complete line of eye protection equipment to meet every mine hazard. Have a talk with the M. S. A. Representative on his next visit to your mine.

The Ful-Vue Goggle (patented) . . . effective eye protection . . . all-round visibility . . . comfort . . . good looks . . . self-adjusting nose pads . . . 6-Curve Super Armor-plate Lenses (patented) have extra strength.

AMERICAN OPTICAL COMPANY

REPRESENTED IN THE MINE INDUSTRY BY MINE SAFETY APPLIANCES COMPANY

4391

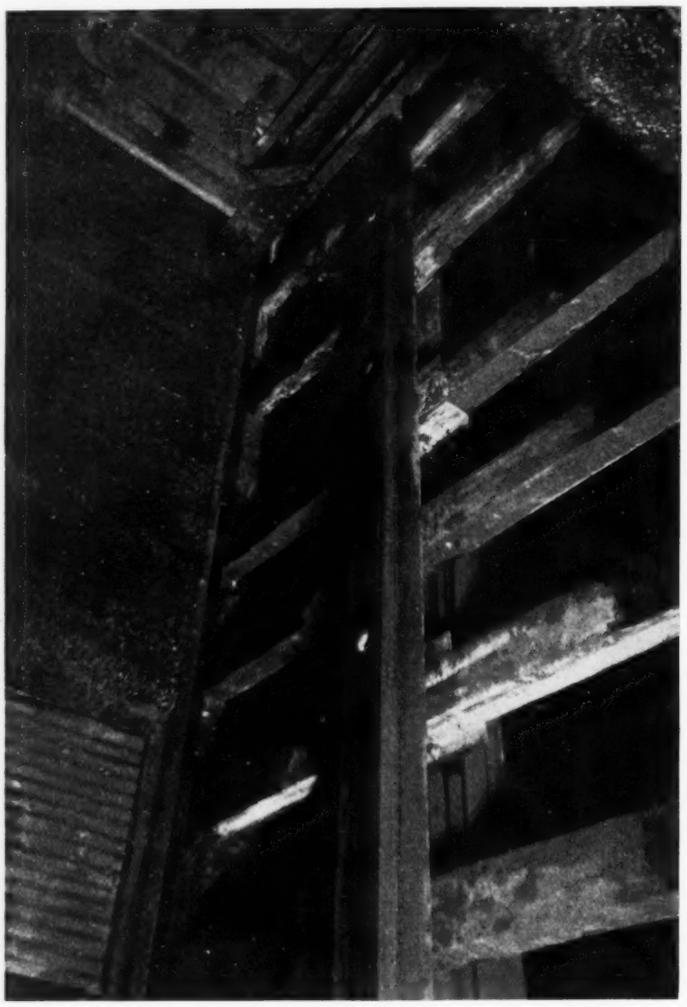
which had just been overhauled and rewired with asbestos cable (in this case Rockbestos), which is standard for the two mines. The leads are being prepared to receive General Electric jack-knife connectors.

Unusual Features Mark Shaft Retimbering At Centralia Coal Co. Operation

TO SECURE the maximum possible degree of permanence, a number of unusual features were incorporated in the shaft retimbering job completed last July at the Centralia (Ill.) No. 5 mine of the Centralia Coal Co. A major objective was tying the guides to the buntons and the buntons into the shaft walls in such a way that movement or displacement of the various members would be practically impossible under normal conditions.

Depth of the shaft is 540 ft. and the total hoisting distance is about 600 ft. Originally, the shaft comprised two hoisting compartments and a downcast air compartment separated from the other compartments by a curtain wall. In retimbering, the original air compartment was converted into a pipe and cable compartment, which permitted moving all pipes and cables out of the hoisting compartments and thus made possible the installation of larger guides. Removal of the curtain wall also increased the upcast area, with consequent benefit to ventilation, now supplied by a new underground fan.

Retimbering involved the installation of all new guides and buntons, and also retimbering the shaft down 10 ft. from the collar with creosoted oak 8x10s. Bunton size is 6x8 in. and they were installed (long side vertical) on 3-ft. centers, except where appearances indicated pressure on the shaft wall, in which cases bunton centers were reduced to about 12 in. Struts installed between buntons are made of 5½x3-in. members.



Looking up from the bottom of Centralia No. 5 shaft, showing new guides and buntons, as well as retaining angles along the shaft walls. Bolts through the latter angles and supplementary lag screws through the guides had not been installed when this photograph was taken

Original 6x8-in. guides, which were set out 2 in. from the buntons, were replaced by new 8x8-in. guides set directly against the buntons. Guides are held in place by 3x5-in. copper-bearing angles bolted to the tops and bottoms of the buntons as indicated in the accompanying illustration. Three angles per 20-ft. guide was the standard adopted, one angle being positioned in the center and the other two at the ends of each guide. In addition, guides were lag-screwed through the remaining buntons, although this is not shown in the illustration, which was made before the finishing touches were put on the job. The ends of the guides were dovetailed and lapped for a distance of 12 in.

To prevent the ends of the buntons from moving sidewise, they were inclosed in channels made by bolting 3x5-in. copper-bearing angles to the shaft walls, as indicated in the illustration. The lag screws (¾x4-in.) holding the angles to the walls were put in on 12-in. centers. Completing the job, bolts were passed through the angles and the buntons and drawn up tight, tying the buntons to the angles and in turn to the shaft walls and thus eliminating any possibility of bunton movement. Like the lag screws through the guides, these bolts had not yet been placed when the illustration was made.

Starting April 16, 1937, the work was carried on 24 hours a day until hoisting was resumed July 27, using the top force divided into crews of three men, each crew with foreman. All drilling was done with air tools supplied by a ¾-in. compressed-air line down the shaft. Both the guides and buntons were painted with beechwood oil at the mine.

Vane Arrangement Signals Mine-Fan Stoppage

To notify the power-house engineer at the Centralia (Ill.) No. 5 mine, Centralia Coal Co., in case of stoppage of the new motor-driven mine fan recently installed underground near the bottom of the air shaft, an air-vane-operated mercury switch was placed in the entry within a few feet of the fan. Gravity return of the vane to a vertical position upon cessation of the air flow causes a siren to blow and a red light to shine in the power-house generating room at the top of the hoisting shaft. A switch is provided for cutting off the siren but the red bulb remains lighted as a reminder to reclose the siren switch, at which time the lamp will go out.

The operating shaft on which the vane, or paddle, *A*, is attached is mounted (see illustration) in sealed ball bearings. The supporting frame, *C*, and the rod are of sufficient length to allow adjusting the vane in or out of the air stream to obtain a proper setting. The mercury switch, mounted on the end of the rod, *B*, is protected by a steel box.

A double-throw switch on the automatic

YOU'LL SAVE *20¢ ON EVERY COMPENSATION DOLLAR PAID IN 1938 IF YOU STOP FOOT INJURIES NOW!

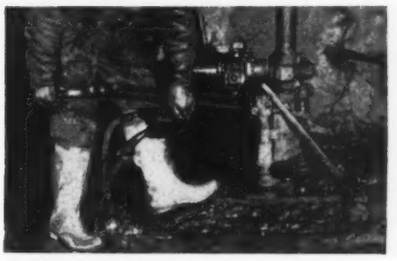
*From reports of five State Labor Departments for 1935

Vast advances have been made in mine safety since the old days, but mining is still the second most dangerous job in America. Why? Simply because EVERY MEANS TO SAFETY HAS NOT YET BEEN ADOPTED!

If every man in your mines were equipped NOW with Lehigh Safety Shoes (with the armor-plate steel toe box) you'd have far fewer foot-injury compensation cases in 1938. That means a saving of roughly 20¢ on every compensation dollar you pay. And since your compensation money comes out of your own pocket, that saving is doubly important!

Lehigh makes a special type of safety shoe for every mining job. It will take our representative less than ten minutes to give you the whole Lehigh Safety story. His call may save you thousands of dollars in compensation. It will cost you just three cents for postage. Can you afford to neglect that saving?

AUTOMATIC SHOVEL OPERATORS *risk crushed toes from tractor belt. STEEL TOE BOXES in Lehigh Safety Shoes have withstood crushing force of 8,000 pounds of steel!*

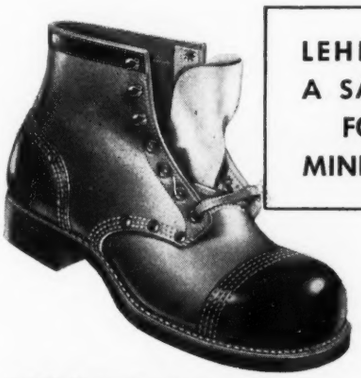


SLIPPING JACKS *in shoring operations have cost untold thousands in smashed toes and feet. LEHIGH SAFETY SHOES give maximum protection at this danger spot!*

COAL SLIDES *account for vast majority of mine foot-injuries. Lehigh Safety Shoes give 100% protection against this hazard!*

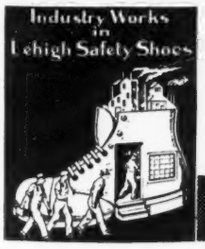
MINE-TROLLEY SHOCKS *are the second most important cause of mining accidents. Mine trolley current CAN'T PASS THROUGH LEHIGH SAFETY RUBBER BOOTS!*

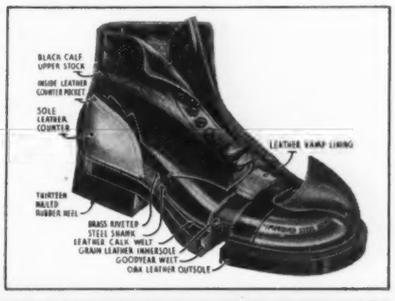
LEHIGH MAKES A SAFETY SHOE FOR EVERY MINING HAZARD



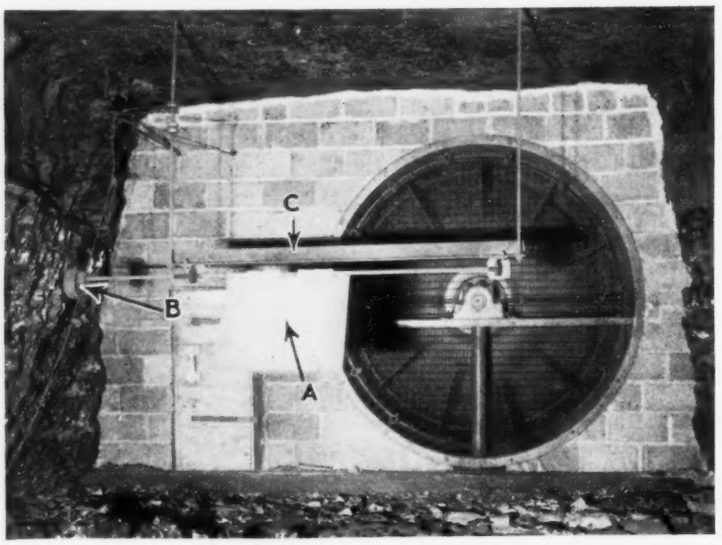
A-802 Natural retan blucher, composition tip, black and natural compo double sole, rubber heel, steel shank, riveted shank to sole. EE 5-12

A-814 Natural retan 8" blucher, leather storm welt, grid rubber outsole, chrome leather middle sole, rubber heel, steel shank, riveted shank to sole. EE 6-12





LEHIGH SAFETY SHOE CO. INC. ALLENTOWN, PA.



Vane and mercury switch do sentry duty at the new underground fan.

starting panel near the fan provides for feeding the 40-hp. driving motor (d.c.) either through its regular lead-covered and armored cable in the air shaft or through the main shaft cables tied to the mine trolleys. Installation of this Jeffrey 7-ft. 2-stage Aerovane fan to replace a steam fan cut the mine ventilation power requirement from 80 hp. to 24½ hp.

Skid Changes Plus Rules Promote Safe Cutting

Major sources of injuries in the operation of cutting machines, investigation at the Crescent Nos. 1 and 6 mines of the Crescent Mining Co., on LaMarsh Creek, near Peoria, Ill., has shown, are long bits, loose bits, careless operation (including improper skid use) and too many skids. To reduce the possibility of injury from the last two causes, machinemen, among other things, must remove all skids from under the cutter bar before the cutter chain is started and must use nothing but standard-type skids developed specifically for increasing safety.

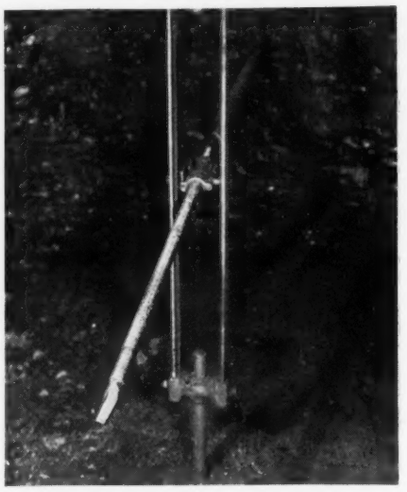
Machine crews are limited to two of the skids in question. These skids, made of tool-steel truck-spring leaves, are 5 ft. long, 5 in. wide and ⅜ in. thick. One end is left square to reduce the possibility of cuts on the hand when a skid is pulled back preparatory to jamming it under the cutting machine. In this operation, in close quarters, the hand may strike the rib or some other obstruction with enough force to cause a severe cut if the end of the skid is sharp. Being made of tool steel, the skids are so hard that it is difficult for bits to get a grip on them and thus there is less chance of their being carried around under the cut or thrown out at the men.

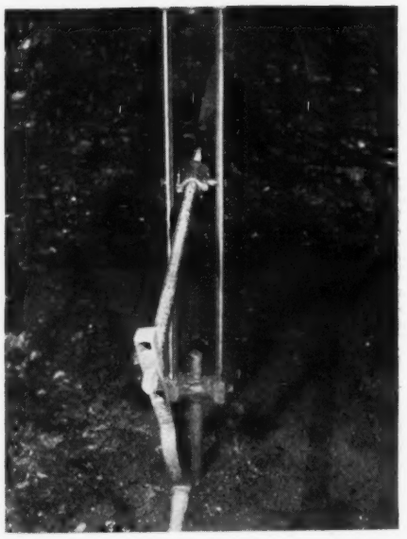
Improved skids reduce coal-cutting hazards

Auger Shank Twisted To Promote Safety

Shanks on the thread bars of the post-mounted hand coal augers used by miners at the Crescent Nos. 1 and 6 mines of the Crescent Mining Co., on LaMarsh Creek, near Peoria, Ill., are given a quarter twist to prevent the crank from coming off in use, with consequent possibility of injury. While, normally, the cranks are supposed to be held in place by cotterpins, actually the pins usually are lost or the men elect to try to drill without them. Consequently, several self-administered knockouts and other injuries have resulted.

By twisting the thread-bar shank it is possible to dispense with the cotterpin with very little chance of the crank coming off in service. This results from the fact the twist makes it necessary actually to turn the crank backward to remove it. As can be seen in one of the accompanying illustrations, the crank stays on the shank when otherwise it would fall off with the conventional straight shank.





Above is a thread bar with a one-quarter twist in the shank; below is the same thread bar with the crank sticking on when normally it would slide off

"SINCE MY LAST CALL ON THE ABOVE PLANT I FIND"

—*A Typical Beginning* of some 25,000 impartial reports by Socony-Vacuum Field Engineers...to guide us in refining oils suited to actual Plant conditions

How Socony-Vacuum Engineering Service can save money in your plant:

1. Curb losses that boost power consumption and costs.
2. Decrease maintenance.
3. Improve production results by greater machine efficiency.
4. Lower lubrication costs.
5. Help your men find ways to devise important economies.

TONIGHT—in hotels across the country—Socony-Vacuum Field Engineers are writing their reports!

News of what Gargoyle Lubricants did today *in service.*

News of new methods...problems.

These hard-boiled facts leave no loopholes. Gargoyle Lubricants must meet operating conditions!

Because they do—Socony-Vacuum "Correct Lubrication" has saved millions in 110 different industries. Improved production. Lowered power, maintenance and oil costs.

The advice of a Socony-Vacuum Engineer may result in surprising economies in your own plant. A word from you will bring him there.

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CORRECT LUBRICATION

GARGOYLE Lubricants

SAVES MONEY FOR INDUSTRY

Read what 71 Years' Lubricating Experience...the Greatest in the Oil Business...can do for You. See Next Page.

THIS MARKETING POLICY MEANS "CORRECT LUBRICATION" FOR EVERY TYPE OF PLANT

INDUSTRY ALMOST ALWAYS FINDS that the controlled use of high-grade Gargoyle Lubricants pays for itself many times over and that they actually cost less to use than ordinary lubricants.

But, for such equipment as does not justify the highest-grade lubricants, Socony-Vacuum Engineers will always recommend a lower-priced lubricant when consistent with true economy.

Socony-Vacuum, with a complete line of products, can supply the lubricants best fitted for the requirements of the individual lubricating job as determined by specific operating conditions.

Socony-Vacuum Engineers bring you years of world-wide experience and direct cooperation with manufacturers of equipment. Lubrication Profit is the inevitable result.

SEND FOR THE SOCONY-VACUUM REPRESENTATIVE: *The services of a trained Socony-Vacuum Engineer are available at all times in helping your men to solve lubrication problems.*

SOCONY-VACUUM OIL CO.

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STANDARD OIL OF NEW YORK DIVISION · WHITE STAR DIVISION · LUBRITE DIVISION · WHITE EAGLE DIVISION
WADHAMS OIL COMPANY · MAGNOLIA PETROLEUM COMPANY · GENERAL PETROLEUM CORPORATION OF CALIFORNIA

GARGOYLE
Lubricants

WORD FROM THE FIELD

Cites 9 Lake Coal Carriers On Demurrage Charges

Nine railroads which haul a total of about 36,000,000 tons of lake cargo coal annually to Lake Erie ports were charged on Nov. 2 by E. A. Burslem, Interstate Commerce Commission examiner, with violating the Elkins Act in that they failed to collect demurrage charges. It also was alleged that in some cases there were infractions of the Interstate Commerce Act because non-compensatory charges were accepted for the transfer of coal to vessels. The respondents named are the New York Central; Pennsylvania; Chesapeake & Ohio; Delaware, Lackawanna & Western; Lehigh Valley; Baltimore & Ohio; Erie; Bessemer & Lake Erie, and Wheeling & Lake Erie.

Eighteen violations were charged against the carriers. The examiner alleged that one road had held 128 cars of coal for 2,156 days without collection of applicable demurrage charges and that another had detained 116 cars of coal for 4,016 days. He also held that demurrage charges put into effect since the investigation was started—in April, 1936—were unduly prejudicial in that they allowed five days' free time instead of three. It was charged, in addition, that other carriers were receiving for the use of their coal docks and unloading facilities rentals less than the actual cost of such facilities.

Indiana Wage Deadlock Ended

A wage agreement was reached Nov. 1 at Terre Haute ending a seven-month deadlock in the Indiana coal field which at times was marked by strike threats. The new scale, which became effective immediately, provides a basic wage rate of $5.65 a day, continuance of the seven-hour day, five-day week and time and one-half for overtime. The rate for motormen and spike-team drivers is boosted 8c. a day; trip riders and trappers get an increase of 20c. a day. The agreement is a compromise, bringing an increase of 57½c over the rate paid under the contract which expired March 31 but falling 35c. short of the $6 demanded by the United Mine Workers representatives. The operators, however, obtained the right to hoist coal on the second shift as well as on the first.

Stearns Building New Plant

Two miles of standard-gage railroad has been completed and work is under way on a six-track steel tipple and preparation plant for a new mine to be developed by the Stearns Coal & Lumber Co., McCreary County, Kentucky. Of an ultimate investment of half a million dollars the outside plant, exclusive of commissary, dwellings and other town buildings, will require an expenditure of $250,000. This includes a mine-track bridge across the South Fork of the Cumberland River.

The plant will be equipped to prepare all sizes of coal, especially stoker grades, which the present markets demand. The Allen & Garcia Co., Chicago, designed the whole job and the steel of the preparation plant and bridge was contracted to the Vincennes Bridge Co., Vincennes, Ind. J. E. Butler, of Stearns, is general manager of the coal company.

Keeping Step With Coal Demand

Bituminous Production

Week Ended	1937 (1,000 Tons)	1936* (1,000 Tons)
October 2	9,630	9,219
October 9	9,450	9,651
October 16	9,580	9,733
October 23	9,412	9,802
October 30	9,086	10,060
November 6	8,600	9,647
Total to Nov. 6	383,187	359,483
Month of Sept	**39,055**	**37,192**
Month of Oct	**40,040**	**43,321**

Anthracite Production

October 2	1,078	1,297
October 9	1,135	1,116
October 16	1,150	1,035
October 23	1,172	890
October 30	1,010	1,033
November 6	941	868
Total to Nov. 6	41,873	46,347
Month of Sept.	**3,507**	**3,874**
Month of Oct.	**4,579**	**4,608**

* Outputs of these two columns are for the weeks corresponding to those in 1937, although these weeks do not necessarily end on the same dates.

Bituminous Coal Stocks

(Thousands of Net Tons)

	Oct. 1, 1937	Sept. 1, 1937	Oct. 1, 1936
Electric power utilities	8,944	8,558	5,744
Byproduct coke ovens	7,761	7,456	5,982
Steel and rolling mills	1,292	1,388	947
Railroads (Class 1)	6,929	7,174	4,304
Other industrials*	13,970	12,475	8,194
Total	38,896	37,051	25,171

Bituminous Coal Consumption

(Thousands of Net Tons)

	Sept., 1937	Aug., 1937	Sept., 1936
Electric power utilities	3,872	4,034	3,662
Byproduct coke ovens	6,284	6,492	5,548
Steel and rolling mills	1,000	1,085	1,037
Railroads (Class 1)	6,867	6,738	6,546
Other industrials*	10,075	9,832	8,364
Total	28,198	28,181	25,427

* Includes beehive ovens, coal-gas retorts and cement mills.

Name Joint Hard-Coal Group In Stabilization Plan

A joint committee, representing the anthracite miners and producers, to confer with federal and Pennsylvania State authorities on legislation for the stabilization of the hard-coal industry was appointed as the result of a series of conferences on Nov. 12 and 13 at the Engineering Societies Building, New York City. The committee is composed of Lieutenant Governor Thomas Kennedy, secretary-treasurer of the United Mine Workers; Henry Warrum, counsel for the union; Ralph E. Taggart, president, Philadelphia & Reading Coal & Iron Co.; James H. Pierce, president, Monarch Anthracite Mining Co.; and J. B. Warriner, president, Lehigh Navigation Coal Co.

Discussion at the conferences, according to John L. Lewis, U.M.W. president, covered the bootlegging situation, interpretation of the wage contract signed by the union and the operators May 8, 1936, and the Pennsylvania workmen's compensation law. Mr. Lewis said the committee would meet in Pennsylvania and Washington on dates to be agreed on later to confer with the Pennsylvania Anthracite Commission and federal authorities.

Scoff at Control Charge

"Fanciful theories" was the characterization given by banking interests to charges by the Anthracite Commission that the anthracite industry and the principal railroads serving it are controlled by the Morgan and Baker financial groups, of New York. The charges were embodied in a report prepared under the direction of C. V. Maudlin, managing director of the Bureau of Applied Economics, Washington, D. C., and made public on Oct. 25 by Governor Earle's commission.

Control, said the report, is maintained through a system of interlocking directorates with anthracite producing companies and hard-coal carrying railroads which "makes it immaterial to such financial interests whether the profits come from mining or from transporting anthracite. Under such a situation they can forego profits on the production of anthracite and recoup them in high freight rates, thereby forcing the independent companies, which must pay the high freight rates, to operate on a very close margin, or at a loss, and preventing them from providing any real competition in the price at which anthracite is delivered to the consumer."

W. Jett Lauck, chairman of the commission, termed the comment of the financiers as "evasive and designed to mislead the general public." Similar charges were made by Mr. Lauck in 1921 and 1922 and were vigorously denied at that time by several bankers and railroad men named.

A plan for consolidation of all private anthracite properties in Pennsylvania into a single private corporation for unified production and marketing was proposed by Mr. Lauck on Nov. 1. Formed voluntarily,

the corporation would be under regulation of the State Anthracite Commission. He said the plan would involve the merging of all mines, breakers, lands and physical properties, but would not involve consolidation of corporate entities.

"Under such a plan," said Mr. Lauck, "anthracite production and capital costs and prices could be reduced to a minimum, competition of oil and other fuels effectively met and the markets for anthracite regained. The proposed corporation would be given by the State the exclusive right, and the protection in this right, to mine and sell anthracite."

To Renew Hard-Coal Pact

Renewal for a period of one year of the present anthracite wage contract, signed May 8, 1936, and expiring April 30, 1938, was agreed to by committees representing the operators and the United Mine Workers following conferences in New York City on Nov. 12 and 13, according to an announcement on Nov. 16 by John Boylan, secretary, Anthracite Conciliation Board. Only approval of the rank and file of the union is necessary to make the extension effective. The pact provides for a seven-hour day and five-day week, except that operators are permitted to operate six days a week in any twelve weeks of the year.

Electrical Group Organizes

Mining men and public-service company officials interested in the practical aspects of power distribution in coal operations in Illinois have organized the Mining Electrical Group. Monthly meetings are planned at which representatives of electrical manufacturing companies will be asked to describe advances in the art. At the first meeting of the new organization, at present largely confined to southern Illinois, 61 members and guests heard D. E. Renshaw, Westinghouse Electric & Manufacturing Co., talk on mercury-arc rectifiers in mining service.

D. D. Wright, division industrial engineer, Central Illinois Public Service Co., Marion, Ill., is president of the association. The other officers are: W. Burnett, Peabody Coal Co., Marion, vice-president; W. O. Faith, Chicago, Wilmington & Franklin Coal Co., West Frankfort, secretary and F. Eubanks, Old Ben Coal Corporation, West Frankfort, treasurer.

Wages and Hours Legislation?

Representative Mary Norton, chairman of the House Labor Committee, has despaired of getting the wages-hours bill out of the Rules Committee by either release or petition to dismiss. She wants to have the bill recalled to her committee for revision, believing that the committee will have to strike out provision for a board and designate the Federal Trade Commission to administer the law. Never enthusiastic about the Black-Connery bill as a boon to labor, Mrs. Norton now believes the proposed revision is a weak compromise and is pessimistic about enacting any wages-hours bill in the special session of Congress which opened on Nov. 15.

Coal Producers and Consumers Foregather To Discuss Their Common Problems

A NEW FORUM for the interrelated problems of producers and consumers was set up last month when the Coal Division of the American Institute of Mining and Metallurgical Engineers and the Fuels Division of the American Society of Mechanical Engineers turned their heretofore independently held meetings into a joint conclave. Reactions to the sessions staged at the William Penn Hotel, Pittsburgh, Pa., Oct. 27 and 28, were so favorable that the innovation may become a precedent for future gatherings of the two divisional organizations. The joint meetings were supplemented by a technical session of the coal group on safety.

How the evolution of the chain-grate stoker has affected combustion rates and performance characteristics was outlined by Gosta Ambro, superintendent, Colgate-Palmolive-Peet Co. J. E. Tobey, manager, fuel engineering division, Appalachian Coals, Inc., emphasized the importance of careful selection of coal for large underfeed stokers. If the operator is to prepare a satisfactory coal for steam generation, both producer and consumer, insisted Henry F. Hebley, advisory engineer, Commercial Testing & Engineering Co., must "become familiar with each other's problems, requirements and limitations."

Negative conclusions on the advantages of chemical treatment of coal and coke, voiced by P. Nicholls, supervising fuel engineer, U. S. Bureau of Mines, Pittsburgh, won hearty indorsement and also provoked vigorous defense of the use of certain chemicals. Fundamentals essential to successful dustproofing were analyzed by H. R. Fife, industrial fellow, Mellon Institute, and P. W. Edeburn, preparation manager, Butler Consolidated Coal Co. Segregation in the coal mass, stated David R. Mitchell, assistant professor of mining and metallurgical engineering, University of Illinois, repeating the presentation of the subject given at the 1937 midwinter A.I.M.E. meeting (*Coal Age*, March, 1937, p.131), is responsible for many of the difficult problems of utilization.

Interpreting Individual Tests

Pitfalls in evaluating individual laboratory tests and sampling methods were pointed out by G. B. Gould, president, Fuel Engineering Co. of New York. A clear distinction, he said, should be made between the accuracy with which a test indicates the quality of a single shipment and represents the average quality which the buyer may expect in a series of shipments. Factors to be considered in the selection of coal for pulverized burning were discussed by B. E. Tate, chief engineer, National Cash Register Co., and for small underfeed stokers by B. M. Guthrie, chief engineer, stoker division, Fairbanks, Morse & Co., and chairman of the engineering committee, Stoker Manufacturers' Association. Need for better standards of selection was stressed by Ralph E. Sherman, Battelle Memorial Institute.

Early chain grates, explained Mr. Anbro, were about 8 ft. long; a sprung arch usually less than 2 ft. above the grate covered the front two-thirds of the length. Combustion rates were limited to approximately 1,500,000 B.t.u. per hour per foot of grate width. Excess air had to be limited to about 150 per cent to keep ashpit losses below 10 per cent. Today stokers 34 ft. long are in service and the average length is about 20 ft. Combustion rates run up to 10,000,000 B.t.u. per hour per foot of width. Furnace-volume releases generally are held to a maximum of 50,000 B.t.u. per hour per cubic foot. Ashpit losses have been cut to as low as 1 per cent on free-burning bituminous, 2 or 3 per cent on barley and 5 per cent on No. 4 buckwheat. Excess air is down to 30 to 40 per cent.

These improvements, explained the speaker, were an evolutionary process (Fig. 1). When forced draft was substituted for natural to burn small-size anthracite, the wind box was partitioned, making the air supply in each zone independent. This cut both ashpit losses and excess-air demands. Later boilers and arches were set higher, with only the short part of the front arch, now known as the ignition arch, left at its original height above the grate. Then the rear arch was lengthened to induce better mixing and combustion of the furnace gases. Eventually the furnace throat formed by the front and rear arches was increased from a minimum of 20 to 30 per cent or more of the grate area.

Handle Wide Range of Fuels

As a result of these and other changes, continued Mr. Anbro, almost any solid fuel of suitable size can be burned successfully on chain and traveling grates. Strongly coking coals, however, are not desirable because the chain grate has no provision for the necessary agitation to break up the coke mass. Ash with a high fusing temperature and a minimum tendency to fuse with refractories also is desirable, but these requirements can be varied with water cooling and shape and size of the furnace. Where bituminous coal is used, at least 6 per cent ash is needed to protect the grate iron, but the ash should not be excessive. Coal should be fairly uniform in size and free from dust. Colgate-Palmolive-Peet Co. sets a limit of 12 per cent through a 3/128-in. opening. For each 1 per cent of such dust the coal is considered to be worth 0.5 per cent less at the plant and 1.0 per cent less at the mine.

Ideal firing conditions are obtained where depth of bed is maintained throughout the length of the fire bed regardless of the natural shrinkage of the coal in burning, contended R. W. Robertson, Andrews-

COAL AGE INDEX

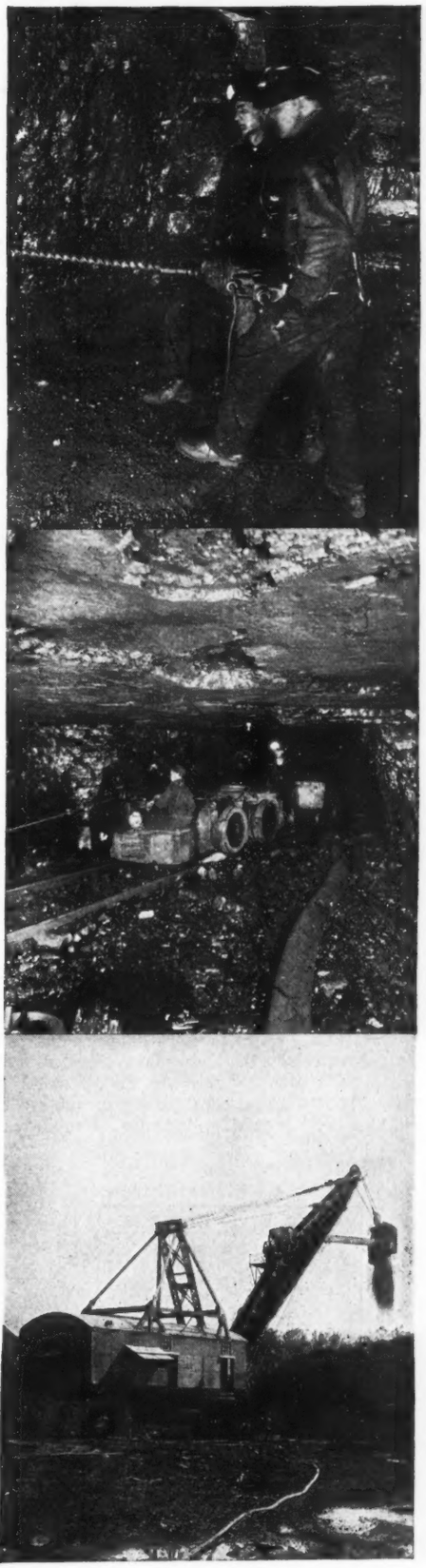
The annual index of Coal Age for 1937 will be found in the eight pages preceding the inside back cover of this issue

HAZACORD

All-Rubber

CORDS & CABLES

For **MINING OPERATIONS**



For Electric Drills *(and all other portable electric tools):*

Hazacord provides the rugged strength to withstand dragging over rough ground, trampling and other inevitable abuses. The 60% rubber jacket is tough, dense and elastic.

For Electric Mine Locomotives

Hazacord Reel Cable with its small diameter, smooth, tough rubber jacket and extra flexible conductor is being used (millions of feet) wherever gruelling conditions demand the best.

For Electric Shovels *(on stripping operations):*

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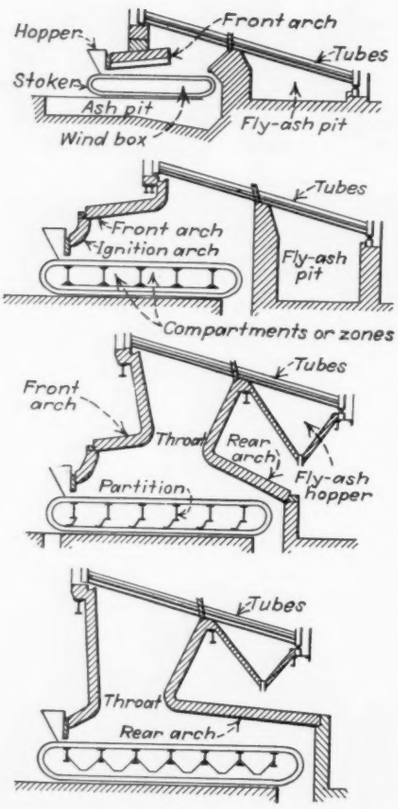

Fig. 1—Evolution of the chain or traveling grate stoker

Bradshaw Co., Pittsburgh. Hitherto, shrinkage has not been compensated and, to make amends for it, the air has been reduced at the rear of the grate and a long arch provided to cover that section. By equalizing air pressure the full length of the grate, ashpit loss has been cut to 1 and sometimes ½ per cent. Chain grates, declared T. A. Marsh, engineer, Iron Fireman Co., are expensive and heavy. They may be used when the banking loss is large but not advisedly where the fire is not banked for long periods.

Careful selection of coal for underfeed stokers, a reduction in the number of tubes in some of the boilers, originally planned for low rating and hand firing, and other modifications, asserted Mr. Tobey, increased materially the horsepower obtained. Before the changes were made, the air was badly "bottled" by close spacing of tubes and the use of building columns. Reduction in heating surface actually increased steam-generating capacity. In the three-year program of elimination coals from 18 out of 130 mines analyzed and tested were found suitable. A single coal finally was selected and this has been burned exclusively for several years.

Coals which differ only slightly in analysis may act quite differently in the furnace. Some coals with ash-softening temperatures of 2,450 deg. F. gave better results than 2,900 deg. F. ash-fusion coals because they did not form a coke mat on top of the fuel bed, to cause imperfect air distribution. Coal with ash that softened at a high temperature clinkered more than low-fusion coal. Too many stokers of the older design fail to agitate the coal sufficiently; on them the best of coals may give less effective results than coals generally rated as less desirable.

Probably, commented E. R. Kaiser, fuel engineer, Battelle Memorial Institute, it would be better to replace such equipment with units that would handle the most economical coal. Because land costs are high, Eastern cities, added L. A. Shipman, combustion engineer, Southern Coal & Coke Co., are disposed to use high air velocities to get high rating. Where there is no such handicap, it would seem best to provide more boilers and use a lower rating.

Imagine a coal 90 per cent of which runs 4 and the rest 45 per cent ash, said Mr. Hebley. It will have a washability curve as in the solid lines of Fig. 2. While a poor coal unwashed, with little loss in heat value it can be made a most desirable product with 4 per cent ash. But if it should have ash and the washability curve shown in the broken line in Fig. 2 it will be difficult to wash, for it cannot be cleaned without excessive loss.

The more the washability curves elbow toward their lower end, the more feasible washing becomes. Thus, if a 5-per-cent-ash coal is wanted from the coal whose characteristics are defined by Fig 3, only 10 per cent of the raw material will have to be rejected, and the reject will have a little less than 80 per cent ash. But to obtain a 5-per-cent-ash product from the coal shown in Fig. 4, 40 per cent of raw feed must be rejected and the reject will be 50 per cent clean coal. Most coals have characteristics which lie between those in Figs. 3 and 4.

Cleaning, Illinois Geological Survey investigations indicate, does not discard with the reject a proportionate quantity of combustible matter. Rejection of 10 per cent of the raw feed of certain coals, for example, "will carry only 2.5 to 6 per cent of the heat representing the fuel discarded," while quality will be improved 540 to 1,060 B.t.u. per pound. Freight rate is a consideration, added Mr. Hebley, for it does not pay to haul a large quantity of low-grade coal to market. Fig. 5 shows the costs at the consumer's plant of enough cleaned coal to give equivalent heat to that of a ton of raw coal with certain freight rates for the cleaned coal. The curves sag down toward the center and the most economical cleaning is that which represents the bottom of the sag, or the lowest cost per heat unit delivered.

Boiler efficiencies are improved with cleaned coal, declared Mr. Hebley, but the improvement depends on the boiler and furnace used. His own figures showed

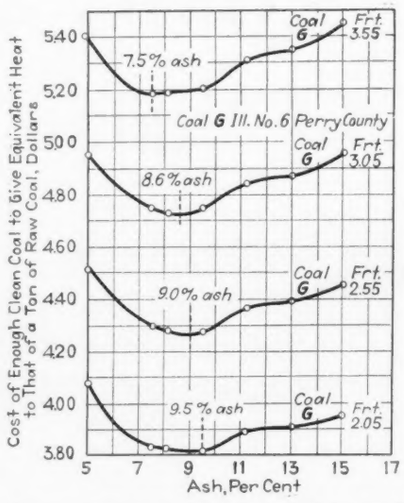

Fig. 5—Curves showing how freight modifies the cleaning problem

increases ranging from 0.09 to 0.74 per cent in efficiency per cent of ash decrease with an average of nine tests of 0.34 per cent. Influence of uniformity in size on efficiency with uncleaned coal ranged from 2.5 to 0.20 in five tests, with an average of 1.45 per cent. The comparison for the most part was between 1½- or 1¼-in. resultant as compared with 1½ x ¾-in. or 1¼ x ¾-in. In determining true efficiency and capacity, maintenance and boiler outage, etc., must be considered over a year or more of operation.

Some ash with a low fusion point forms droplets and a pebbly clinker that passes out of the critical zone without causing

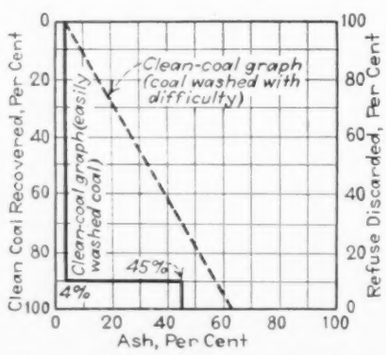

Fig. 2—Ideal washability graph for easy-cleaning coal

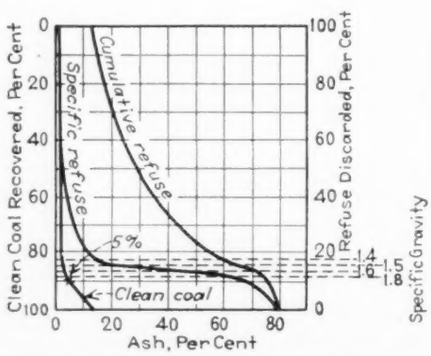

Fig. 3—Washability curve of a coal easy to clean

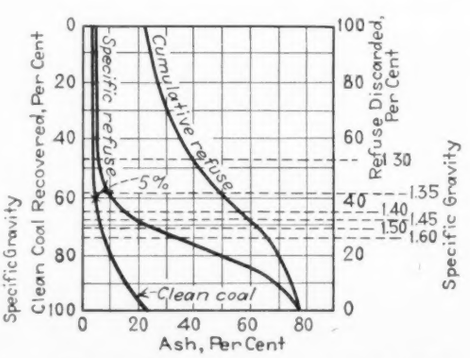

Fig. 4—Similar curve of a coal difficult to clean

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LUBRICATION ENGINEERING

Table I—Increase in Percentage Efficiency for Each Per Cent Decrease in Ash

Authority	Increase, Per Cent
U. S. Bureau of Mines	0.20
B. M. Thornton (Imperial Industries, Ltd.)	0.24
E. S. Grummell	0.33
R. Lessing (World Power Conference)	0.33

trouble, explained Mr. Hebley. Other ash expands and covers the grate with a molten sheet, shutting off the air. Every per cent of moisture in the fuel causes a loss of about 0.1 per cent in efficiency, but such a loss easily may be neutralized by the greater benefits of decreased ashpit losses, ability to maintain an even fire and carry a greater load.

According to Heywood, continued Mr. Hebley, the relative resistance of the banded constitutents of coal to grinding is: fusain, 0.47 per cent; very bright coal, 1.00; streaked bright coal, 1.50; dull coal, 2.18. Fusain, however, may sometimes grind with difficulty, for it may contain nodules of hard material. Grinding cost, Mr. Hebley suggested, could be greatly reduced by eliminating the dull coal. However, the minus 14-mesh coal is so small that, according to R. M. Hardgrove, less work is required to grind it; on the Continent of Europe, some of it, Mr. Hebley said, is used without grinding and gives 70 to 80 per cent boiler efficiency.

Coal, declared B. M. Bird, coal preparation and ore dressing, Battelle Memorial Institute, should not be mechanically cleaned merely because cleaning is in style. Moreover, lowering the ash-fusion point does not result always in increased clinkering. As the chief cost of preparing coal for the market is handling and not cleaning, it is usually best to clean it. Screening will often clean fine coal, remarked G. R. Delamater, assistant vice-president, W. S. Tyler Co., citing, among others, a case where 75 per cent of a wet 20-mesh West Virginia coal thereby was rendered acceptable to the market. At Jeffersonville, Ky., it had been found that ¾-in. slack should be tempered with 12 per cent of moisture, added Mr. Anbro.

Ash Shields Grates From Heat

Coal with too little ash may cause excessive injury to grates and tuyeres from excessive heat, declared W. E. Caldwell, Consolidated Edison Co. of New York. More ash is needed with low-volatile coal than with high-volatile. The blowing over of the coal causes excessive temperature. Nut and slack give good results with the underfeed stoker. Oiling helps some coals but, with one gallon of oil per ton, belts have been injured. Pyrite is undesirable in any coal. The constitutents of the ash may be of great importance with superheaters and extreme high temperatures. Boilers can be designed to suit almost any kind of coal, asserted Prof. Mitchell. Action of gas and dust on preheating equipment must be considered, stated W. G. Stephan, president, Stephan Co., for the dewpoint of the gases is raised when sulphur trioxide is present. High moisture in coal, said A. W. Thorson, Detroit Edison Co., clogs hoppers and spreaders and is disadvantageous. With Iowa coal and chain-grate stokers, declared another, 7 to 12 per cent of moisture is essential.

Tests by the U. S. Bureau of Mines have shown that relatively small changes are caused in the burning of coal by addition of chemicals, declared Dr. Nicholls. "Effectiveness of chemicals in reducing caking of coal were restricted to weakly caking coals, thick firings and lower air rates." Moreover, "the effects of 4 lb. of chemical per ton," the maximum treatment usually given, "were insignificant except with the most weakly caking coals." He added that though too much moisture may interfere with feeding or handling the coal or the high water content may hinder the initial ignition of the surface of the bed, there is little question but that an increase in water will be more effective than the addition of 4 lb. per ton of any chemical. Tests of Eastern coals with certain proprietary products show that, within the range of duplication possible in tests of commercial boilers operating under normal service, treatment does not affect combustion.

In 1910 the Bureau tested sea water and calcium-chloride solutions, and between 1916 and 1930 it subjected to test a treatment with a mixture of about 78 per cent common salt, 14 per cent potassium chlorate and small quantities of potassium permanganate and dichromate, manganese dioxide, sodium carbonate and sulphates, which was the type of mixture most used between 1910 and 1926. In 1930 only about ½ lb. of chemical was being used per ton of coal. As the tests were made with rates of burning which ranged from 3 to 14 lb. per square foot per hour, enough data were obtained to prove that "there was no justification for the claims in regard to the coals used."

In the main investigation, continued Dr. Nicholls, 25 salts or oxides of aluminum, ammonium, boron, calcium, chromium, copper, fluorine, lead, manganese, molybdenum, potassium, silicon, sodium, zinc and nitric and hydro-chloric acids were tested. Cost of material was not considered. In commercial practice usually not more than 3 lb. of chemical has been used per ton of coal, and sometimes as little as a ½ lb., but in the tests 4 to 40 lb., based on anhydrous weights of chemical, was applied. The methods of test were such that the small effects of even 4 lb. of chemical were measurable. When using 20 to 40 lb. of certain chemicals, changes under favorable conditions were appreciable, but when 4 lb. is used, a change in size of fuel, attendance and setting of dampers, etc., will override the effects of the chemical.

Treatment can improve combustion only by reducing the caking of coals, according to Dr. Nicholls. With a weakly caking coal, treatment reduced caking markedly, but with a strongly caking coal it made no measurable difference. Treatment reduced caking more effectually the thicker the layer of coal fired, but it had a negligible effect with thin firings, even with Illinois No. 5, which was the weakest caking coal to which the treatment was applied. Treatment also reduced caking more as the supply of air to the furnace was decreased, but the effect was not as appreciable as with increases in thickness of coal fired.

Water Keeps Coal From Caking

Water also reduces caking, asserted Dr. Nicholls. It is the more effective with coals that will absorb it as well as hold it on the surface, but ability to hold moisture is a characteristic of the most weakly caking coal and decreases with increase in caking power. Illinois No. 5 coal sized to ¼ or ½ in. will hold 12 per cent, but Pittsburgh coal only 3 to 4 per cent. With Illinois No. 5 coal and Indiana No. 4 coal, 8 per cent of water reduces caking almost as much as 2 per cent of any other treatment tried. Mid-Western coals, in general, cake weakly and hence are more affected by treatment than Eastern.

Nothing indicated that chemicals influenced the expulsion of volatiles from coal or that any increase in rate of burning was associated with direct action between chemical and hydrocarbons. Chemicals shield the carbon of the fuel from heat and may do so to such degree that even with increased reactivity treatment may slow the progress of a freshly lighted or recuperating fire. Too much chemical, therefore, delayed "pick up" with heavy treatment, and 4 lb. per ton helped but little. Coke was shielded more than coal because it evolved no gases to elude the shield. Chemicals are more active in underfeed burning, for the fuel is fed into the low-temperature zone, where it can be more potent. Under some conditions mixture of sodium carbonate with coal before high-temperature coking might be helpful. Light or heavy treatment does not aid ignition of coal or coke in furnaces.

In general, soot or tar in gases at the stack is increased by chemical treatment—a little with light treatment, more with heavy. It will not diminish smoke deposits, though with heavy treatment such deposits, especially with salts of copper and lead, might be burned.

No chemical, added Dr. Nicholls, improves nature of clinkering; 4 lb. of chemical per ton usually does not change measurably either quality or quantity of clinker,

Coming Meetings

- American Mining Congress: annual meeting, Dec. 1-3, Mayflower Hotel, Washington, D. C.
- Coal Mining Institute of America: annual meeting, Dec. 9-10, Fort Pitt Hotel, Pittsburgh, Pa.
- Indiana Coal Mining Institute: annual meeting, Dec. 11, Terre Haute, Indiana.
- New River Coal Operators' Association: annual meeting, Dec. 14, Mountainair Hotel, Mt. Hope, W. Va.
- Iowa Coal Operators' Association; annual meeting, Dec. 14, Fleming Building, Des Moines, Iowa.
- Colorado Mining Association: annual meeting, Jan. 10 and 11, 1938, Pueblo, Colo.
- American Engineering Council: annual meeting, Jan. 13-15, 1938, Washington, D. C.
- College of Mines, University of Washington: annual meeting, Jan. 17-22, 1938, Mines Laboratory, University of Washington, Seattle, Wash.
- Fifth International Heating and Ventilating Exposition: Jan. 24-28, 1938, Grand Central Palace, New York City.
- American Institute of Mining and Metallurgical Engineers: annual meeting, Feb. 13-17, 1938, 29 West 39th St., New York City.

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but, when it does, the slag fuses more completely. With 40 lb. per ton of chemical, clinker is increased and the slag is more thoroughly fused if the chemicals used lower fusion temperature. Nor is there improvement where fusion temperature is increased by chemicals, for increase in quantity and size of clinker offsets higher fusion temperature. Of all chemicals used, all oxides except silica, alumina and chromium oxide act as fluxes. Effect varies, of course, with composition of ash in fuel.

Chemicals appear to give better results with straight screenings than with larger coal, asserted W. D. Langtry, Commercial Testing & Engineering Co. They prove more effective where high rates of combustion are used. With treated coal the grates are less rapidly destroyed by combustion. Not all tests showed that improved operation accompanied treatment. In some cases untreated coal gave the greater efficiency, but in some cases the differences were so small that they could easily have been masked by trifling operating differences.

In chemical treatment, halogen compounds, urged Henry Fraser, Johnstown, Pa., bring about an oxidizing reaction; nascent chlorine from chlorine compounds promotes such chemical changes. Treatment enables some of the sulphur to be retained, and carbon dioxide and sulphurous acid in the flue gas are neutralized by the alkalies in treatment, thus reducing corrosion. Nothing will suppress the vendor of chemical treatments for coal, shot out Dr. Rose. When he is told that a chemical used alone is ineffective, he is ready with the reply: "Mine has six, and they give accordingly a sextuple effect."

According to Mr. Kaiser, the Crecelius type of chemical treatment makes clinker weak and easy to break. Sodium may bind the dust and prevent its detrimental effect. It had been hoped, said Dr. Nicholls, that when chlorine compounds were used that element would unite with iron and, being volatile, would pass off with the gases. Ferric oxide, it was expected, would be formed, but, if so, he had been unable to find it.

Wax Averts Coal Degradation

Treatment of Freeport mine-run with waxy compounds before it reaches the tipple gives a 70- to 80-per-cent reduction of fly dust in the tipple, a satisfactorily treated commercial slack coal and a reduced degradation of the coal in the tipple, but the coating is distributed not according to weight of particle but to its exposed area, declared Dr. Fife, speaking for himself and Mr. Edeburn. Hence, domestic sizes require further treatment.

Soft-coal fly dust might be defined as comprising all dust below 200-mesh, but all dust, at least all below 60-mesh, should be held. Petrolatum is being atomized at 450 lb. pressure at a spraying temperature of about 120 to 130 deg. C. and the spray tips are 4 to 5 in. below the coal stream. Possibly 70 per cent of the petrolatum strikes the coal before solidifying and about 10 per cent of the wax-oil blend floats as a solid unit throughout the tipple. When the spray unit is hooded and adequate steam or atomized hot water is used, an acceptable spray unit for inside tipple use will result, as has been demonstrated commercially in the spraying of stoker sizes at the truck-loading boom.

The spray inclosure will be connected to an exhaust fan through a conical wet-dust collector. Thus, it is hoped, all danger of a wax-mist ignition or a coal-dust explosion within the tipple will be avoided. The results will be better working conditions, less loss of dust, less undesirable breakage of coal in screening and a coal more salable because it will not agglomerate when frozen, will not weather, or break in storage or cause fly ash.

Sized coal is worth what it costs, asserted H. A. Schultz, Stock Engineering Co., reading the notes of Arthur Stock, for segregation thereby ceases to be a problem. Moreover, the coarse-coal zone in the furnace arising from the use of less closely sized coal injures furnace walls by its excessive heat. There is also loss of fuel.

After explaining that coal quality varies roughly in accordance with the laws of probability but with a slightly higher percentage of the coal less free from ash than the average percentage, Mr. Gould said that variations in quality of coal

Blank & Stoller

Paul Weir

Nominated chairman, Coal Division

should be considered in drafting and operation of such coal contracts as include penalties and premiums, or penalties only, as customary in government contracts. If an arbitrary standard of quality is specified for the calculation of penalties and premiums for each shipment, the seller assumes a risk of specific penalties and premiums and can determine these if he has a frequency diagram for his coal. If penalties only are stipulated, the quality specified becomes a limit and the chances of exceeding it by specific amounts can be predicted. If only one sample is tested, the penalty or premium that will result may be based on the occasional extreme variation of the quality of the coal. When only penalties are provided the effect is to set a standard of quality that is much higher than average, if all deliveries are to escape penalty. Much of Mr. Gould's paper duplicates his previous references (*Coal Age*, August, 1937, p. 384).

Too often the low figure obtained in the analyses of several lots of coal is regarded by the purchaser as not being the result of an inevitable variation in coal or sampling but as an exhibit of what the mine operator could obtain if he used due diligence and honesty, urged T. W. Guy, consulting engineer. The other less favorable analyses are regarded as attempt to "put something over on the purchaser."

A distribution curve in which percentages of coal would be plotted as abscissas and ash per cent as ordinates would be more convincing than the frequency or probability curve. On it could be ruled the average percentage of ash, said B. A. Landry, associate fuel engineer, U. S. Bureau of Mines.

At the mines of the Island Creek Coal Co., asserted A. J. Bartlett, chief mine inspector, at Thursday afternoon's safety session, with J. T. Ryan, vice-president, Mine Safety Appliances Co., in the chair, more tonnage is produced per lost-time injury by mechanical than hand loading in total and in all kinds of hazards except those from electricity, coal cutters and other machinery, where, however, the lead of hand loading is small. Two of his mines have held the best fatality record in West Virginia for several months. No. 1 mine has operated 5½ years and produced 4,026,293 tons; No. 2 mine, 5 years and produced 3,606,933 tons, both without a fatality. Since their most recent fatalities, No. 7 mine has produced 1,259,947 tons; No. 21, 1,340,110 tons, and No. 14 1,025,909 tons.

To show what possibilities of further progress were still before them, Eugene McAuliffe, president, Union Pacific Coal Co., sent the following comparison with the record of his company which was read by N. G. Alford, Eavenson, Alford & Auchmuty.

Table II—Lost Time Injuries—Island Creek and Union Pacific Coal Companies

	Island Creek	Union Pacific
Total lost-time injuries	317	53
Tons produced per lost-time injury:		
Inside employees	15,509	68,462
Outside employees	148,365	657,322
Inside and outside employees	14,041	62,003

Table III—Eye Injuries, Union Pacific Coal Co., 1925-1936 Inclusive

Year	Eye Injuries	Year	Eye Injuries
1925	8	1931	8
1926	17	1932	9
1927	5	1933	3
1928	9	1934	0
1929	11	1935	1
1930	14	1936	1

Preferring the man-hour record, Mr. McAuliffe gave the following figures for his company: Inside employees, 78,005 man-hours per lost-time injury; outside employees, 7,048,845; and inside and outside employees, 62,003. He added that the roof of the Union Pacific Coal Co.'s mines was treacherous and that of Island Creek less dangerous. Sixteen eye injuries in the Island Creek mines, Mr. McAuliffe's manuscript went on to say, are more numerous than they would be if goggles were provided. Table III shows the record of the Union Pacific Coal Co.

From this record can be seen clearly when goggles were introduced. The one injury in 1935 was not during working hours: that in 1936 was from a blow of an axe that use of goggles would not obviate. Sometimes, said Mr. Alford, safety is obtained with more difficulty where hazards are least obvious, as the

(*Turn to page* 161)

whole organization is less readily "sold" on an accident-prevention program.

In developing a mine, two intake and four return headings should be provided with a solid pillar between intakes and returns, read J. T. Ryan, Jr., Mine Safety Appliances Co., from an article written by W. B. Hillhouse, chief, Alabama Department of Mines. Despite the general impression, crosscuts should be driven as infrequently as possible. Split ventilation is preferable to continuous.

Poorly built ventilation doors, leaking 500 to 5,000 cu.ft. of air per minute, are an extravagance. Doors should be tight and in pairs; approaches to overcasts should be streamlined. Packwalls in longwall should be tight or air will short-circuit and not go to the face. The only two major accidents in Alabama in the past ten years, costing nineteen lives, were due to the imperfect tightness of packwalls which let the air pass through the gob.

Only two cuts may be made ahead of the foremost crosscut at the Union Collieries Co.'s mines until the crosscut is completed, declared G. A. Shumaker, superintendent, Renton Nos. 3 and 6 mines. Outby crosscuts are stopped tight as soon as inby crosscuts are finished and not merely by curtain or door. Lost time from high gas percentage is investigated as carefully as an accident and regarded as a condition that will recur unless causes are controlled. To keep methane to 0.5 per cent or less provides an inadequate safety factor. Quantity of air traveling is more significant than gas percentage.

Longwall Used From Necessity

Longwall, said J. C. Nicholson, general superintendent, Dominion Coal Co., speaking for T. L. McCall, mining engineer, is not desirable if room-and-pillar methods are feasible. So long as the workings could be maintained using the latter method, the Dominion Coal Co. followed it. Along the long faces, 30,000 cu.ft. of air is coursed. Rock-dusting principally is concentrated near the working faces, for explosions are most likely to occur where men are working.

Caution in men can be determined by prominence of the zygomatic arch or cheek bone, declared G. R. Lightowler, personnel management consultant, New York. A man without so much caution may be a safe worker, if he has the defense characteristic, which is marked by the prominence of the bony bridge of the nose just ⅛ or ¼ in. below the lower eyelid when looking straight forward. Too high a defense is a sign of aggressiveness and may make a man dangerous to his fellows. If higher or lower than the point indicated it has another significance. If it is a hollow, then the defense mechanism is low.

Inadequate plant equipment for steam production often makes it essential to use the most suitable pulverized fuel regardless of cost, asserted B. E. Tate. Old units may be available, but to use them would result in inefficient operation. In a case he cited, where heat content and delivered price of two coals were identical, use of one of these coals for a year to carry a 9,000-kw. load would cost $40,247,- more. Almost any coal can be pulverized and burned, but selection is often as necessary as with the ordinary stoker.

Grindability index may vary from 40 for the Winifrede seam in Boone County, West Virginia, to 107 for the Lower Kittanning seam in Indiana County, Pennsylvania; that is, a mill grinding the first coal will grind 2.67 times as much if working on the other.

When a friable coal is ground, less power is needed, less wear per ton occurs and parts may be permitted to wear more before replacement. Pulverizing cost seems to vary as the cube of the grindability index. However, low-volatile coals, which are easy to grind, are difficult to ignite, hence high-volatile coals need not be ground so fine as low-volatile.

In a dry-bottom pulverized-fuel furnace, coal having the highest ash-fusion temperature need not necessarily be the most desirable for that furnace. Coal having a border-line ash-fusion temperature may give a porous sandlike deposit on the refractory walls, thus insulating them, reducing air filtration and protecting them from temperature changes, and that without slagging the tubes.

J. B. Morrow
Retiring chairman, Coal Division A.I.M.E.

Care should be taken in mixing coals. Two coals with ash-fusion temperatures of 2,485 and 2,705 deg. F. had an ash-fusion temperature when mixed of 2,284 deg. F. and two with ash-fusion temperatures of 2,478 and 2,513 deg. F., when mixed, gave an ash-fusion temperature of 2,850 deg. F.

High ash content does not form such a critical and determinate obstacle in the selection of fuel for pulverized-coal firing as the already recited characteristics. Difficulties increase gradually with increase in ash, added Mr. Tate. Between 20 and 40 per cent of the ash may be expected to remain in the furnace and cannot be sold or given away.

Plunger or ram conveyors have been most satisfactorily applied to such underfeed stokers as have a feeding capacity of more than 300 lb. per hour, declared B. M. Guthrie, chief engineer, stoker division, Fairbanks, Morse & Co. They distribute the fuel evenly through a long, narrow retort, but the coal cannot be conveyed a long distance from hopper to furnace, so the hopper must be placed adjacent to the boiler, thus limiting its size and, accordingly, its capacity to a small fraction of the hourly feeding rate.

Screw or worm conveyors are more generally used, but they deliver coal to the retort only at the end of the screw and the distribution of the coal along the length of the retort depends on its construction. A short taper at the discharge end has a beneficial effect. With the usually less costly screw conveyors, large-capacity hoppers can be provided located almost at any distance from the boiler, leaving the front of the boiler unencumbered. A reciprocating block, or blocks, in the bottom of the retort aids distribution.

In stokers burning up to and including 60 lb. per hour (Class 1 stokers) a screw can be made with shorter pitch or a smaller diameter in the hopper section so that it will not clog at the delivery end.

Nos. 1 and 2 buckwheat anthracite are adapted to use in Class 1 stokers. Too much undersize or dust, which burns up quickly and produces ash that fuses to larger pieces, results in inefficient burning. Too much oversize increases the ashpit loss, as not all the larger coal is burned. In mixing anthracites only those having the same burning rate should be chosen.

Need exists, asserted Mr. Sherman, for a declaration of the kind of coal required for each type of stoker. No one—users, equipment manufacturers or coal producers—seems to know what coal should be selected, and some manufacturers blandly recommend their stokers for any kind of fuel and conditions. Because of the need for dependability, it is not well always to use the most economical coal—that which costs less per 1,000 lb. of steam delivered, including all maintenance and labor costs—because that kind of coal may not carry the load, due to heavy clinkering, excessive smoke at heavy loads, etc.

Some Western coals, said Mr. Tobey, are more grindable than southern West Virginian coals but are destructive of pulverizers. Life of grinding elements with a coal of a grindability of 60 on the Hardgrove scale was 4,000 hours, but, in contrast, a second coal with a grindability of 100 kept its grinding elements running 25,000 hours; yet the proportions required to pass through a 200-mesh screen were 65 and 75 per cent, respectively. The maintenance, power and fixed charges per ton were 11.09 and 6.74c. per ton, respectively. The hardest coal gave the lowest aggregate figure. When the grindability index is low, added O. de Lorenzi, wear and power cost are greater. Of course, pyrite should be removed, or these relations will not hold.

Mining Waste Is Excessive

Waste in mining—now 50 per cent of the coal in the seam—is excessive, asserted C. F. Hosford, Jr., chairman, National Bituminous Coal Commission, at the banquet. Its reduction is an aim of the Commission. It could be cut from 250,000,000 tons annually to, at least, half that figure. Most coal is purchased not on a quality but on a price basis. Last year, a large proportion of the tonnage was sold for a little less than 10c. a ton below cost of production. It is the intention of the Commission not to raise prices unduly but to eliminate such losses.

Paul Weir, consulting engineer, Chicago, is the nominee for chairman of the Coal Division for the coming year. Official nominees for other offices in the division are: C. A. Gibbons, general manager, Susquehanna Collieries Co., vice chairman; A. W.

Hesse, chief mining engineer, Buckeye Coal Co.; R. H. Morris, general manager, Gauley Mountain Coal Co., and J. E. Tobey, manager, fuel engineering division, Appalachian Coals, Inc., members of the executive committee. Formal announcement of the results of the balloting last month will be made at the A.I.M.E. midwinter meeting next February. J. B. Morrow, preparation manager, Pittsburgh Coal Co., is now chairman of the division.

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Open Door and Lighted Match Cause Mine Explosion

A door held open by a latch, contrary to State law, caused an explosion, mild in dynamic effects, but killing 34 men at the Mulga mine of the Woodward Iron Co., at Mulga, Ala., at 10:45 p.m., Oct. 15, according to the report on Oct. 29 of a special committee headed by W. B. Hillhouse, chief State mine inspector. "Someone latched the 12th Right ventilating door, supposedly the motorman or triprider, as they were gathering the loaded trip. This permitted an accumulation of firedamp causing the explosion." The 12th Right has eight working faces, and from 30 to 35 minutes is needed to place empties, gather loads and return to the door. As many as four posts were found in the explosion area with wood latches which were intended to hold doors open.

Moreover, a shotfirer, the base of whose Baby Wolf keylock flame safety lamp was found open 13 ft. from the freshly shot face of the second inby parallel of 12th Right, an intake, says this report, had opened his lamp, which was provided with a self-igniter, to ignite the wick with a match preparatory to taking an observation for methane. Before the coal at the face was shot, the line brattice was 11 ft. from the face and the place apparently had been rock-dusted on one side to within 8 or 9 ft. of the face and on the other side within 20 ft. A burned match was found near the base of the lamp.

As the working place rose about 10 per cent to the face, the gas had opportunity to accumulate in the absence of ventilation. Hanging on a prop in the last crosscut of the 12-X heading (on the opposing side of the 2d Cross Haulage from 12th Right) matches and cigarettes were found in the pocket of a shirt belonging to the machine-runner foreman. The shotfirer's clothes in the 12th Right contained matches and cigarettes.

Employed at the mine were 604 men, 229 of them being in the mine at the time of the explosion, 65 of whom were in the section affected. In all, 195 men escaped uninjured and 34 were killed—22 by afterdamp, four by afterdamp and burns and eight by burns.

All overcasts are of "good reinforced concrete construction," permanent stoppings are of mine rock faced with a clay-and-cement mix or preformed cement blocks. Edison permissible electric cap lamps are used for lighting. Water is used on cutter bars to allay dust. From 66 to 70 per cent inert dust is needed to make the coal dust inexplosive. "The mine is apparently well rock-dusted by machine to the end of the trolley wire in entries and airways and, beyond the end of the trolley wire in entries, airways, rooms and breakthroughs, rock dust is applied by hand. Standard and approved practice requires that rock dust be not over 15 ft. from working faces." About 100 tons of rock dust is said to have been used per month over the entire mine.

The mine has five intakes, and the fan was reported Oct. 13 to be delivering 192,480 cu.ft. per minute at 4.5 in water gage. The entire mine liberated from 900,000 to 1,000,000 cu.ft. of methane daily, and the return from the 2-X section contained 0.55 to 0.80 per cent methane, and from the entire mine from 0.30 to 0.35 per cent. In 6½ years, ending Oct. 14, Mulga produced 2,164,597 tons without a mine fatality.

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Battelle Continues Research On Stoker Problems

Research in problems of stoker combustion, undertaken by Battelle Memorial Institute for Bituminous Coal Research, Inc., is still following the three major lines of inquiry started at the Columbus (Ohio) laboratory several months ago. These are studies of the characteristics of coals for small stokers, coal for industrial stokers and combustion on large underfeed stokers. Results to date in the cooperative study of oil treatment of coal for dustproofing (*Coal Age*, May, 1937, p. 228; November, p. 90) will be summarized in a paper to be presented at the annual meeting of the American Society of Mechanical Engineers in New York the week of Dec. 6.

Experiments with a small stoker having a special agitating device (*Coal Age*, September, 1937, p. 82) have led to the tentative conclusion that such a device makes it possible to burn strongly coking coals which were difficult to handle in a stoker not so equipped. Absence of coke trees, it was felt, should permit operation with somewhat lower excess air and greater efficiency with moderately strongly coking coals and with less smoke in the "off" periods. Coals tested in small stokers during recent weeks included samples from the Upper Freeport, Pittsburgh No. 8 (Ohio) and Sewell seams.

In addition to further experimental work on the segregation of coal with the use of the laboratory model bunker, studies of the measurement of temperatures and the sampling of gases from the fuel bed of a large stoker at the Hell Gate station of the Consolidated Edison Co. of New York also were continued. Recent work in the study of combustion in underfeed stokers has been concentrated on an investigation to determine the effect of change in the number of tuyeres in the retort for the admission of air by the successive removal of tuyere rings from the stoker. Removal of one air ring, it was indicated, had little effect on the process of combustion, but the effect of the removal of the second ring was noticeable.

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Youngstown Mine to Reopen

Remodeling work has been started at the Youngstown mine, Lemont Furnace, Pa., in preparation for resumption of operations on Jan. 3. The mine, which has been leased by the Bortz Coal Co. from the H. C. Frick Coke Co., will employ about one hundred men when the plant is reopened.

I.C.C. Grants Coal Rate Rise; Further Increase Sought

Increases in freight rates on a limited list of basic commodities, including bituminous coal and coke, expected to yield an additional $47,500,000 annually to the railroads, were authorized on Oct. 22 by the Interstate Commerce Commission in Ex Parte 115. The boost in tariffs on coal and coke alone is expected to yield $31,383,391 in added revenue; these increases range from 3 to 15c per ton in the Western district and from 3 to 10c in other districts; on lignite, from 2 to 8c. The advances were to take effect Nov. 15.

The Commission based its action on what it termed the recognized need of the carriers for increased revenues. Because such a large proportion of the increase will come from coal transportation and the further fact that $6,265,053 of additional bituminous haulage revenues will go to the Chesapeake & Ohio, Norfolk & Western, and Virginian railroads, for which the Commission said there was "not a shadow of justification," it was stipulated that the increase in soft-coal rates should remain in effect only until Dec. 31, 1938. Also the Commission announced that it expected the roads benefiting from the rise in coal rates to pool all such revenues for their common benefit.

One week later the carriers served notice, through the Association of American Railroads, that they would immediately ask for an increase of 15 per cent in the level of freight rates, except as to coal and a limited number of other commodities, "for which certain maximums will be asked in each instance." This announcement elicited a statement by the National Bituminous Coal Commission that "this Commission and the Consumers' Counsel will not only oppose further coal-rate increases but will also ask the Interstate Commerce Commission to reconsider the action already taken." The margin between income and operating expenses for the bituminous coal industry, the statement says, "was squeezed so thin that it vanished completely years ago. It has faced not merely a crisis but stark poverty for so many years that few coal men can remember today the last era of prosperity. And as for a total net income, it has none; instead it is operating at an actual and increasing loss."

Seek Big Boost on Anthracite

The railroads filed their petition for the additional increase in rates on Nov. 5, asking, with respect to bituminous coal, a 15 per cent rise in rates as increased in Ex Parte 115, with a maximum of 15c per ton, except where under Ex Parte 115 the increase was 15c the maximum will be 10c. On anthracite, which was unaffected under Ex Parte 115, the proposal is to add 15 per cent to existing rates with a maximum increase of 25c per ton. The Commission announced on Nov. 8 that hearings on the petition would begin in Washington, D. C., on Nov. 29.

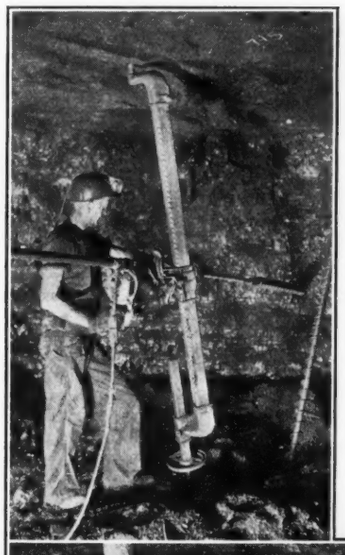
Unqualified opposition to the proposed increases was expressed by the National Coal Association at a meeting of its executive committee on Nov. 8. The freight-rate structure, it was pointed out, "has been out of line for a long time in that coal has been made to pay more than its fair share of the transportation charges," and coal-producing associations and retailers' organizations were urged to resist not only the

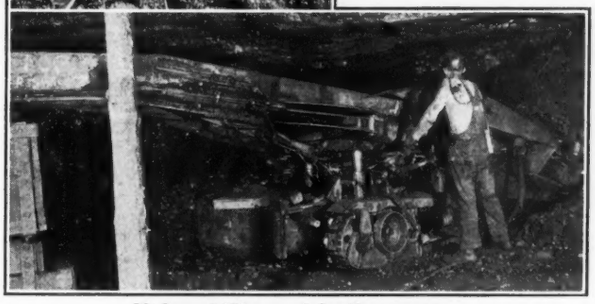
(*Turn to page* 166)

Bell & Zoller workers wear

HY-TEST SAFETY SHOES

FOR GREATEST SAFETY, SERVICE AND COMFORT





Modern drilling and loading operations typical of Bell & Zoller Mines

Safety comes first in the Bell & Zoller operating program; and the fact that this great organization has standardized on Hy-Test Safety Shoes to protect the feet of its workers, must be regarded as significant. At Ziegler Nos. 1 and 2 and at Crescent Nos. 1 and 6 mines, Hy-Test Safety Shoes have long since been accepted as the surest means of reducing foot injuries to the minimum, and the program for foot safety has now been extended to include Centralia mine.

In order to afford the greatest possible foot protection, Bell & Zoller have carefully selected certain types of shoes for the various mine operations, which, from experience, they have found to be best adapted to the job. Prominent among their selection is H724 . . . shock-proof shoe which is widely used in electrified mines.

H724 Black Glove safety blucher. Heavy composition sole, and vulcanized (non-metallic) rubber heel. Anchor Flange insulated steel box toe. One piece (Saf-Eze) back part. Non-metallic eyelets.—Protector last.

Goodyear Welt

Saf-Eze makes for perfect comfort at the heel. With Saf-Eze there can be no ripping — no binding, chafing or rubbing.

HY-TEST SAFETY SHOES

DESIGNED AND MANUFACTURED EXCLUSIVELY BY

INTERNATIONAL SHOE COMPANY, ST. LOUIS, MO.

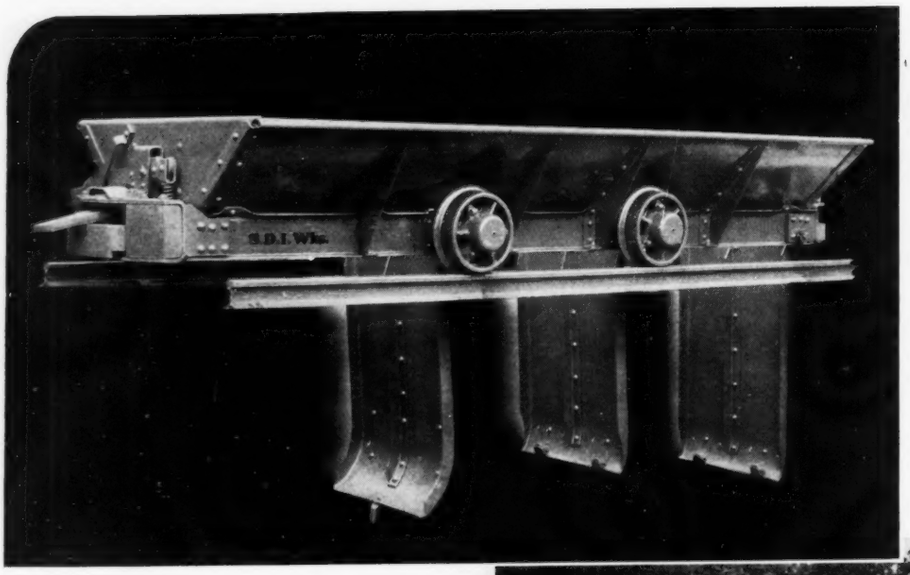
THE WORLD'S LARGEST SHOE MANUFACTURER

ST. LOUIS

Let's Use Our Heads To Save Our Feet

BLUE DIAMOND

—with S



At Chevrolet, Kentucky—The Seventh Blue Diamond mine to be equipped with "Automatics".

WHY?

Because, of all the different types of cars they have used (End-Dumps, Rotary Dumps, etc.), the Automatic Bottom Dumping Car has proven to be the most economical.

Blue Diamond's new layout of Hopper and Tipple, at Chevrolet, Kentucky. Note the circular construction of tracks at the hopper. Here, loaded S-D Automatics are weighed and dumped automatically, but never stopping . . . always moving on.

1924 Blue Diamond buy First Creek Mine, in Hazard, Ky. field, already equipped with S-D Automatics. Here, they learned about low hauling and dumping costs with S-D Automatics.

1926 Blue Diamond discard rotary dumps and old cars in TWO mines at Blue Diamond, Ky., replacing them with Automatics.

1931 Blue Diamond install Automatics at their new Mayflower Mine, St. Charles, Va.

1932 Blue Diamond discard rotary dump and rotary dump cars, Bonny Blue mine, St. Charles, Va., replacing them with Automatics.

1936 Blue Diamond switch their Eagan, Tenn. mine to Automatics—250 S-D Automatics replacing a considerably greater number of end-dump cars.

1937 And, Now! Chevrolet mine is modernized with 350 S-D Automatics. Another large quantity of end-dump cars were discarded.

MARCHES ON
S-D AUTOMATICS

MORE THAN TWENTY-ONE HUNDRED S-D AUTOMATICS (A TRAIN OF MONEY-MAKING CARS MORE THAN FIVE MILES LONG), SUPPLIED TO ONE OF THE LARGEST AND MOST CAREFULLY OPERATED MINING COMPANIES IN THE INDUSTRY—BLUE DIAMOND COAL CO.

• • •

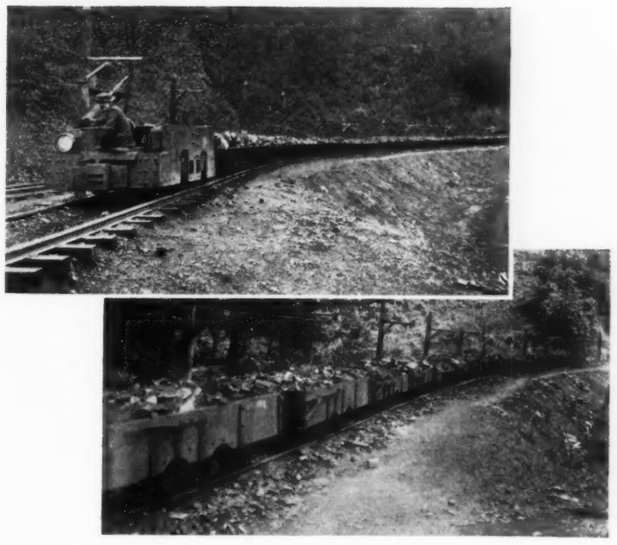
We ask you—with such an unusual record for consistent repeat installations with one firm, where operating costs are weighed and watched so carefully—how can any progressive operator fail to recognize the wisdom of, at least, investigating this remarkable car, even if he thinks he doesn't need them? Our records show case after case of operators who thought they didn't need S-D Automatics, but, after investigating, discovered, to their surprise, that they couldn't afford to be without this money making car.

This history of S-D Automatics, with the Blue Diamond Coal Co., is convincing evidence of the merit of our cars, yet, it isn't an isolated case. Many operators, throughout the United States, have learned through experience that S-D Automatics cut hauling and dumping costs to the core. And, invariably, operating cost sheets at automatic installations show many other savings incident to the use of S-D Automatics.

Wide awake operators everywhere are learning that the facts published by Sanford-Day deserve investigation. They are realizing that old methods and obsolete types of mine cars are liabilities. These facts are not being brushed aside. Many progressive operators are discovering that a new, high profit in coal production is the result when S-D Automatics are installed.

SANFORD-DAY IRON WORKS, Inc.

KNOXVILLE -●- TENNESSEE



THE CHANGE OVER AT CHEVROLET. One glance at the new over the old system shows that increased production and lower hauling and dumping cost is assured.

Look at the new over the old method of dumping. Isn't it apparent to you that this modern, S-D Automatic system of hauling and dumping coal must be a great money saver?

increases proposed but to express complete opposition to the unreasonable level of rates now in existence.

The Virginia Corporation Commission set Dec. 7 for a hearing, in Richmond, on an application by carriers in the State for permission to raise their rates within the State to conform with the schedule of increases granted on interstate shipments by the I.C.C. in Ex Parte 115.

The Pennsylvania Public Utility Commission on Nov. 10 rejected an application of railroads for intrastate freight-rate increases conforming to the advances allowed by the I.C.C. on interstate traffic pending hearings by the State body. The application was suspended until an investigation could be made to determine the reasonableness of the rises sought. The State Board of Public Utility Commissioners of New Jersey ordered on Nov. 13 the suspension of proposed increases in intrastate carload rates filed by 26 carriers pending an investigation and hearing to determine whether the rises are reasonable and lawful.

Engineers Study Fuel Problems

Nearly three hundred fuel engineers, power-plant superintendents, operating engineers, chemists and others attended the fuel engineering conference at Kalamazoo, Mich., on Nov. 3, sponsored by Appalachian Coals, Inc., assisted by the local unit of the National Association of Power Engineers, Inc.; Kalamazoo Association of Purchasing Agents and the Kalamazoo Valley Chief Engineers' Club. J. E. Tobey, manager, fuel engineering division, Appalachian Coals, Inc., presided.

R. E. Howe, president, A.C.I., made an address pointing out the need for cooperation between fuel engineers and power-plant operators and the following papers were presented: "Segregation of Coal in an Industrial Steam-Plant Bunker," Ralph A. Sherman, fuel engineer, Battelle Memorial Institute; "Technical Consideration of Factors Involved in the Purchase of Coal," T. W. Harris, Jr., division purchasing agent, E. I. du Pont de Nemours & Co.; "Effect of Coal characteristics on Underfeed Stoker Operation," A. W. Thorson, mechanical engineer, Detroit Edison Co.; "Coordination of Combustion Research With Practice," L. A. Shipman, combustion engineer, Southern Coal & Coke Co.; "Pulverized Coal for Steam Generation," R. M. Hardgrove, research engineer, Babcock & Wilcox Co. There also was a round-table conference.

Personal Notes

CLAUDE ALLEY has been appointed foreman at the Lynchburg mine of the Lynchburg Coal & Coke Co., Kyle, W. Va.

R. T. ARMSTRONG has been made foreman at the Eunice mine of the Princess Dorothy Coal Co., Eunice, W. Va.

CHARLES BELL has been named foreman at the Hitchman mine of the Hitchman Coal & Coke Co., Wheeling, W. Va.

J. I. COMBS has been appointed superintendent of the Capito (Ky.) operations of the Atlas Coal Co., a subsidiary of the Black Diamond Coal Mining Co., Birmingham, Ala. Mr. Combs has been associated with coal mining in the Alabama district for a number of years.

Harris & Ewing

Miss Josephine Roche

JOHN C. COSGROVE has been renamed as the National Coal Association's representative on the Committee of Ten—Coal and Heating Industries, with headquarters in Chicago. Mr. Cosgrove is chairman of the committee, which consists of representatives of the bituminous coal industry, boiler manufacturers, stoker makers, plumbing and heating equipment, etc.

STANLEY DEAL has been appointed foreman at No. 4 mine of the Kelleys Creek Colliery Co., Ward, W. Va.

ALVA DOUGLAS has been made foreman at the Avis mine of the Avis Eagle Coal Co., Lyburn, W. Va.

L. E. GRANT has been named superintendent at Eunice mine of the Princess Dorothy Coal Co., Eunice, W. Va.

MILTON H. FIES, vice-president, DeBardeleben Coal Corporation, has been elected president of the Birmingham (Ala.) Kiwanis Club, effective Jan. 1.

M. E. HALL has been made foreman at No. 33 mine of the Pocahontas Fuel Co., Bishop, Va.

V. HENSLEY has been named foreman at Midvale No. 2 mine of the Koppers Coal Co., Gamoca, W. Va.

JOHN HILTON has been appointed foreman at Dubree No. 2 mine of the Maryland New River Coal Co., Winona, W. Va.

R. P. HOGAN has been appointed general superintendent of the Peacock and Mt. Harris plants of the Colony Coal Co., in Wyoming.

LOUIS LASALLE has been made superintendent of the Dines and Megeath mines of the Colony Coal Co., in Sweetwater County, Wyoming.

JAMES LINDLEY has been named foreman at Powellton No. 4 mine of the Koppers Coal Co., Kimberly, W. Va.

L. D. MCNULTY has been named foreman at the Dayton mine of the Dayton Coal Corporation, Surosa, W. Va.

T. J. O'BRIEN, president, Kemmerer Coal Co., was reelected president of the Southern Wyoming Coal Operators' Association at its adjourned annual meeting. Other officers renamed are: W. J. THOMPSON, president, Colony Coal Co., vice-president, and L. W. MITCHELL, executive secretary.

M. L. O'NEALE, in charge of the P.W.A. program in West Virginia since its inception, in August, 1933, first as State Engineer and later as State Director, became general manager on Nov. 1 of Hugh Miller Associates, an engineering and architectural corporation of consultants, designers and supervisors of mining, industrial and public improvements, with headquarters at Charleston, W. Va. At various times he has been superintendent, Seaboard Coal & Coke Co., Coal City, Ala.; general superintendent, Connellsville Basin Coke Co., Morgantown, W. Va.; general manager, La-Mar Coal Co., Fairmont, W. Va., and chief engineer and safety director, Bethlehem-Fairmont Coal Co., Shinnston, W. Va.

M. F. PELTIER, vice-president in charge of sales, Peabody Coal Co., was reelected president at the ninth annual meeting of the Illinois Coal Operators' association. Other officers renamed are: FRED S. WILKEY, secretary; O. M. GORDON, treasurer, and THURLOW G. ESSINGTON, general counsel.

JOHN D. PETREE, formerly N.R.A. compliance director for Alabama and more recently State head of the National Emergency Council, became Alabama regional manager for the National Bituminous Coal Commission on Nov. 1.

FRED RADIKE, Monarch Coal Mining Co., Centralia, Wash., has been elected a member of the Producers' Board of District 23, under the National Bituminous Coal Act, succeeding James H. Flanagan, resigned.

ERSKINE RAMSAY, chairman of the board, Alabama By-Products Corporation, has been designated as king of the Birmingham Christmas Carnival, fostered by the Birmingham Junior Chamber of Commerce.

A. B. RAWN, JR., has been appointed superintendent at No. 9 mine of the Carbon Fuel Co., Wevaco, W. Va.

WARREN R. ROBERTS has resigned as instructor in the Logan district, Mining Extension Department, West Virginia University School of Mines, to become sales representative in the Logan territory for the Hazard Wire Works division of the Okonite Co., Wilkes-Barre, Pa.

MISS JOSEPHINE ROCHE, Assistant Secretary of the Treasury, which office she held since Nov. 15, 1934, resigned effective Nov. 1, to return to the post of president of the Rocky Mountain Fuel Co. The company had been without a president since the death, in September, of J. P. Peabody, her successor. Miss Roche was asked by the President to continue as a member of the Interdepartmental Committee for Coordination of Health and Welfare Activities of the government, of which she has been chairman since its creation by Executive Order a year ago.

G. M. SAMPLES has been appointed foreman at the No. 5 mine of the West Virginia Coal & Coke Co., Omar, W. Va.

HEWITT SMITH has been made superintendent at the No. 6 mine of the Kelleys Creek Colliery Co., Ward, W. Va.

F. B. SNYDER has been named foreman at the No. 9 mine of the Carbon Fuel Co., Wevaco, W. Va.

E. E. STEPHENS has been appointed su-

PATENTED

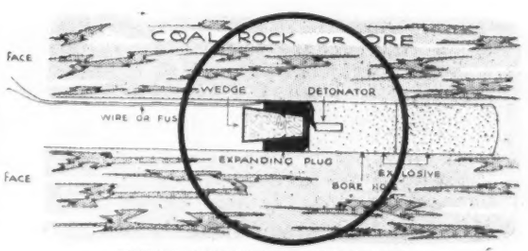
Advantages of The Heitzman Safety Blasting Plug

1. The Heitzman Safety Blasting Plug is a substitute for tamping and acts as a safety device in case of misfires.
2. In case of misfire, a small charge is placed on top of the first plug, and then fired with another plug. The detonation will fire through the first plug.
3. The plug seals the charge airtight and makes the explosion more effective because the shot is confined in the back of the hole; which produces more ore, coal or rock with less explosives.
4. Produces a greater percentage of prepared sizes and lump coal.
5. The plug is the only tamping required.
6. Takes less explosives.
7. In metal mines where it becomes necessary to fill the drill hole to the mouth with explosives, leaving no room for tamping, the plug provides an excellent seal. A depth of only three inches is required to seal a charge airtight.
8. In wet places it is difficult to blast because dry tamping is not available. Water does not affect the plug. It works as well in wet as in dry places.
9. In pitchwork where holes are from 45 degrees to vertical, the charge is easily sealed. No bursting of dirt bags and tamping running out of the hole.
10. Provides a uniform tamping.
11. Saves time and cost making dirt bags for tamping.
12. Saves the time and cost of drilling extra holes in case of misfires.
13. Saves the extra explosives needed when a shot misfires.
14. Saving in explosives is more than twice the cost of the plug.
15. Miners say: "You can now carry your tamping in your vest pocket."
16. Simple to use—No training is necessary.
17. If an air cushion is desired, the plug can be lodged anywhere in the drill hole.

USE HEITZMAN SAFETY BLASTING PLUG!

Breakage in coal operations is expensive—as every mine executive knows. Some of it is unavoidable, but much of the "fines" can be reduced immediately by using *smaller charges* and pulling more coal with those charges. How? With the Heitzman Safety Blasting Plug. This simple, inexpensive device is used in place of dirt bags for tamping. The plug is pushed against the charge and expanded. This confines the full force of the explosion to the bottom of the hole—making less explosives do more work and materially reducing shatter. In addition, the Heitzman Plug is really *safe* because missed holes can be fired without drilling either the old or a new hole. Miners like to use them and operators are quick to appreciate the real economies they effect.

Write us today for facts, figures and free samples of the Heitzman plug—be sure to give size of drill bit you are using.



CROSS SECTION SHOWING APPLICATION OF THE PLUG

HEITZMAN SAFETY BLASTING PLUG CORP.

SHAMOKIN, PENNSYLVANIA

perintendent at the Ingram Branch mine of the Koppers Coal Co., Wriston, W. Va.

W. C. THOMPSON has been made superintendent at the Cranberry mine of the New River Co., Sprague, W. Va.

LELAND H. WINGER, Shinnston, W. Va., has joined the Extension Department, West Virginia University School of Mines, as instructor in the Beckley district.

Colorado Inspectors Named

Four new deputy coal-mine inspectors have been named by Thomas Allen, chief inspector of Colorado, and have qualified, as follows: Finley McCallum, District 3, with headquarters at Steamboat Springs; J. J. Roddy, District 4, Montrose; George H. Smith, District 5, Canon City; Myron Williams, District 6, Walsenburg.

Mr. McCallum was formerly with the inspection department for a number of years; Mr. Roddy recently resigned as superintendent of the Keystone mine of the Keystone Coal Co., at Routt; Mr. Smith was for many years foreman of the Morley mine of the Colorado Fuel & Iron Corporation; and Mr. Williams has had extensive experience in the mines in the Oak Creek field.

I.C.C. to Hear Rate Protests

Hearings on rate protests have been set by the Interstate Commerce Commission for Dec. 8 at the New Yorker Hotel in New York City and Jan. 5 at Washington, D. C. On the first named date consideration will be given to the complaint of a group of anthracite producers against freight rates on hard coal from northeastern Pennsylvania to New York tidewater. Commissioner Eastman and Examiner Hosmer will be in charge of the proceedings.

Examiner Trezise will preside at the latter date, when allegations are presented that the Chesapeake & Ohio and other carriers charge "unjust and unreasonable" rates on bituminous coal shipped from mines in southern West Virginia, Virginia and eastern Kentucky to Newport News, Lamberts Point and Sewells Point, Va., for reshipment by water to New England. A property owners' committee representing coal producers instituted the proceeding, which was joined by a number of New England trade bodies and manufacturers.

The Railroad Commission of Kentucky also has filed with the I.C.C. asking for an investigation of rates and differentials on bituminous coal from western Kentucky to Chicago and the West and North, alleging that present rates are unduly preferential to Illinois and Indiana producers.

A petition asking the right to intervene in support of the hard-coal operators' complaint was filed with the I.C.C. on Nov. 13 by the United Mine Workers. The petition, which was signed by Thomas Kennedy, international secretary of the union and Lieutenant Governor of Pennsylvania, asserted that the union had a direct interest in the proceedings because a large number of mine workers have been thrown out of employment and the working time of the remainder greatly reduced. Furthermore, "your petitioners believe that excessive freight transportation charges on anthracite have contributed to the decrease in its consumption."

Operation With Profit Holds Attention Of Illinois Mining Institute

MORE profitable operation was the dominant theme of the 45th annual meeting of the Illinois Mining Institute, held at the Hotel Abraham Lincoln, Springfield, Ill., Nov. 5. Turning the spotlight on specific aspects of this major problem, speakers at the meeting—the largest in the history of the organization—discussed how attainment of this objective could be facilitated by safer and more efficient mining methods, employment of modern equipment and practices, cost-control accounting, vigorous sales promotional efforts, and federal regulation. Research also had its innings with a motion-picture presentation showing the different burning characteristics of the clarain and vitrain components of coal.

One way to reduce costs and, inferentially, increase profits is to reduce accidents. Although the direct costs of injuries are no mean drain upon income, the hidden costs, C. F. Herbert, superintendent, safety engineering department, Bituminous Casualty Corporation, pointed out, are estimated to be four times as great. A wreck, for example, may result in compensable injuries to motorman and triprider; these are direct and readily recognizable costs. But, in addition to the inescapable interruption to the normal flow of production while cleaning up the wreck, repairing the physical damages may involve major shop jobs on locomotives and cars, realigning tracks and retimbering. On top of this is the possibility that such a wreck may ignite coal dust and cause a major explosion.

Based on average direct cost of $3,500 per fatal accident, continued Mr. Herbert, fatalities cost Illinois operators $325,500 last year. During the same twelvemonth, the total compensable injuries reported was 3,165. Experience indicates, however, that the ratio of non-compensable to compensable cases is 10 to 1 and that the average direct cost is $100 per injury. That meant a total direct cost to Illinois mines in 1936 of $3,165,000, or 6.1c. per ton. If hidden costs are included, the total rises to $15,825,000, or 30.5c. per ton. And Illinois, he added, is not alone in this showing.

Responsibility Up to Management

Improvement can come only as management recognizes its primary responsibility for and leadership in accident prevention. Too much of the time of safety engineers and inspectors is spent correcting practices which directly violate specific provisions of the mining laws with respect to ventilation, timbering, roof control and haulage. Too little time is left for training the mine personnel in accident-prevention work. If safety really is to be promoted, warned Mr. Herbert, every executive of the company from president to face boss must believe that accidents can be prevented and that safety and efficient operation go hand in hand. Safety is as much a part of the boss' job as getting out tonnage. Men will not cooperate in safety work unless convinced that management itself is sincere in its campaign.

"Methods of mining," said John W. Broadway, auditor, Bell & Zoller Coal & Mining Co., "are changing. New legislation requires many special statements to be compiled from the records. There are new methods in the merchandising of coal brought about by the demands for different sizes and better quality at minimum prices due to competing fuels. Therefore, it behooves the management to see that accounting practices are installed and maintained to keep abreast of these changes, and at all times reflect intelligently to the superintendents, sales department and directors the true costs."

Bell & Zoller operations, he explained, include three fully mechanized shaft mines, a partially mechanized slope operation and a fifth mine on a strictly hand-loading basis. The accounting system must be flexible enough to meet these different conditions. Reports and forms are so standardized that they can be used at any of the mines. The general books are kept at Chicago; detailed accounting is done at the local mine offices. Where more than one mine is operated, as at Zeigler, a central office handles the payrolls and accounting for that particular group of mines.

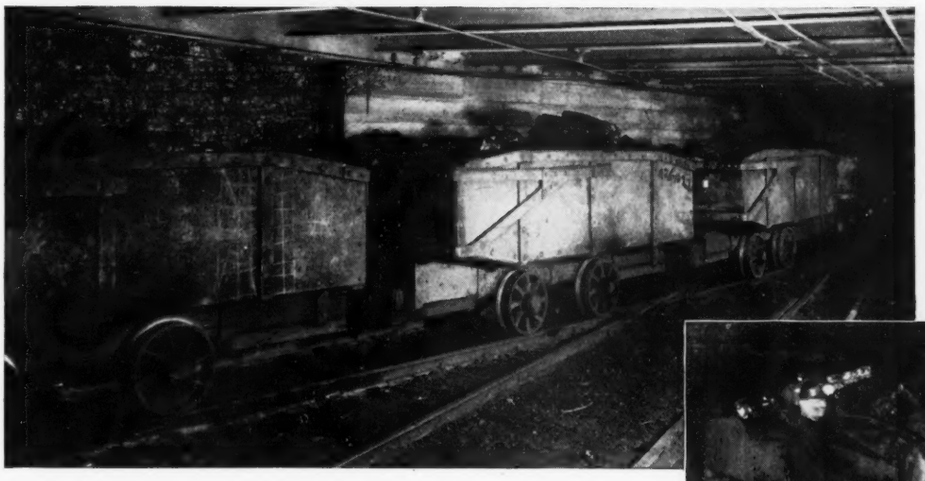
Direct labor charges absorb 65.9 per cent of the mining sales-dollar; taxes incidental thereto and compensation often run this figure up to 70 per cent of the total production cost. Precautions against costly errors and dishonest practices in compiling payroll records, therefore, are essential. The Bell & Zoller payroll form is a sheet lined for 40 names and columned for the employee's check number, name, occupation, hours worked or tonnage hoisted by days and for the pay period, rates of pay, and gross and net earnings with deductions itemized. Each payroll sheet is balanced separately and a recapitulation made to secure the grand total.

Foremen Keep Time Records

Each foreman must keep the time for the men under him in a pocket-size book which has spaces for the employee's check number, name, hours worked, rate of pay and occupation. At the end of the pay period, continued Mr. Broadway, this time book is turned in to the central office, where it is checked with the payroll and retained as the original record of entry. The foreman also fills out a daily time sheet in duplicate showing the employee's check number, work performed, hours worked and rate of pay.

One copy of this sheet is given to the timekeeper at the mine for daily posting to a general time book, which, in turn, is sent to the central office periodically throughout the pay period for posting to the payroll. The second copy goes to the cost department. If discrepancies are found in checking the foreman's time-book against the daily postings, these discrepancies are called to the foreman's attention and adjustments are made before the payroll is closed. Deductions known as "daily issues" are compiled on a payroll supplement sheet; deductions, such as Social Security taxes and the union check-off, which require only one posting for the period are posted direct to the payroll.

In addition to these payroll records, a separate "Earnings Card" also is made for each employee. This card is used in compiling reports for the Social Security



A few of the 1,875 Timken-equipped mine cars at Bell & Zoller Mines.

Tapered Roller TIMKEN BEARING EQUIPPED

A symbol of quality for any piece of equipment with which it is associated

One of the Timken-equipped Joy Loaders at Bell & Zoller Mines

1,875

Timken-Equipped Mine Cars Are Used at the Bell & Zoller Properties

Haulage practice at the mines of the Bell & Zoller Coal Mining Company will be on a 100% TIMKEN Bearing basis when the modernization program of the company is completed.

At the present time 1,875 Timken-equipped mine cars are in service as follows: 150 at Ziegler Mine No. 1, 600 at Ziegler Mine No. 2, 425 at the Centralia Mine and 700 at the Crescent Mine. Older cars will be replaced gradually with modern all-steel cars until the entire mine car equipment is operating on TIMKEN Bearings.

TIMKEN Bearings are also used extensively in other equipment at these up-to-date mining properties. For example 43 Joy Loaders each containing from 40 to 51 TIMKEN Bearings handle the heavy job of loading the total output of 13,000 tons of coal per shift. One of these Joy Loaders—Type 11 BU—equipped with 50 TIMKEN Bearings established an all-time record a short time ago by loading 1,292 tons in one 7 hour shift.

Link-Belt and Robins belt conveyors operating on Timken-equipped idlers likewise play an important part in the speedy and economical handling of the coal at the Bell & Zoller mines. These include all of the conveyor systems used in the modern preparation plant which handles the entire output of the Ziegler Nos. 1 and 2 mines and the 440 ft. slope conveyor at the Crescent No. 6 mine.

The 15-ton electric locomotives in use at the Centralia mine are also Timken-equipped.

The Rock Island "Rockets" Roll On TIMKEN Bearings

GLIDE—as you ride a Timken-equipped train

THE TIMKEN ROLLER BEARING COMPANY, CANTON, OHIO

Manufacturers of Timken Tapered Roller Bearings for automobiles, motor trucks, railroad cars and locomotives and all kinds of industrial machinery; Timken Alloy Steels and Carbon and Alloy Seamless Tubing; Timken Rock Bits; and Timken Fuel Injection Equipment.

TIMKEN

TAPERED ROLLER BEARINGS

Herbert H. Taylor, Jr.
President-elect, Illinois Mining Institute

Board, the federal income tax unit and the company's own compensation department. Earnings are carried forward and balanced so that the quarterly Social Security Board reports (Form SS-2A) can be quickly compiled. Since the total amount of earnings given on these reports "must balance with the grand total of taxable earnings" shown on the recapitulation of the monthly returns (Form SS-1), accuracy is essential. The payroll check and the employee's statement are combined and perforated so that the latter may be detached and retained by the worker for his record.

What Records Should Show

If a daily cost statement is to be valuable to operating executives and men in charge of the mines, declared Mr. Broadway, "it must be sufficiently detailed to reflect the costs of the different phases of operation and any gain in efficiency or reduction in costs due to changes in methods of mining." The Bell & Zoller daily cost statement is divided into 21 general accounts, viz.: (1) Yardage and deadwork, (2) face loading, (3) cutting, (4) drilling and shooting, (5) haulage, (6) underground power, (7) tracklaying, (8) timbering, (9) ventilation, (10) general underground, (11) hoisting, (12) power generation, (13) preparation, (14) general top, (15) general safety, (16) railroad tracks, cars and engines, (17) storage coal, (18) electric cap lamps, (19) supervision, (20) engineering, and (21) office and clerical.

Where necessary, these general accounts are further divided into sub-accounts. Face loading, for example, is broken down into: (a) Hand-loading undercut coal, (b) conveyor loading, (c) operating loading machines, (d) maintenance of loading machines, and (e) clean-up. Labor and supply costs are charged separately to each account. There also is a further division as between fixed charges, operating cost and non-recurring expenses. Improvements, new equipment and rehabilitation work come under the last-named classification. "With 'fixed charges' and 'non-recurring expenses' segregated, the 'operating cost' should reflect the efficiency of the operations as well as any gain or loss due to changes in operating methods."

A daily issue sheet of supplies used, detailing items, unit prices and accounts to which they should be charged, is furnished by the warehouse department. Since central warehouses were established at the Zeigler and Crescent operations, inventories and supply accounting have shown worth-while savings (see page 132 of this issue for special story on supply handling). Charges spread over more than one mine are entered on a pro-rate sheet columned the same as the daily cost statement. The detail of the costs of operating the washery plant serving the Zeigler mines, for example, is carried on this sheet and the charges are prorated and transferred to the cost statement at the end of the month.

Setting Up Compensation Costs

In computing mining costs, continued Mr. Broadway, a reserve approximating the cost per $100 of payroll charged by insurance companies and reduced to a per-ton basis is set up for the compensation department. All expenses incurred by this department are charged against this reserve; the balance in the reserve is carried forward from year to year. Compensation costs are allocated to six general accounts, viz.: (1) Hospital, which is divided into fifteen sub-accounts to give detailed analysis of costs of operating a company hospital at Zeigler; (2) office—including salaries of adjuster, safety engineer, office supplies and miscellaneous; (3) medical, which covers all medical costs except those of the doctor in charge of the company hospital; (4) legal; (5) compensation paid, and (6) excess insurance.

These costs are entered on a monthly statement. This statement also includes a summary of outstanding liabilities such as balance due on adjusted claims, compensation due but unclaimed, and estimated outstanding liability, medical and hospital costs on unadjusted claims. An estimate is made each month of the cost of cases still unsettled and a list of such cases is attached to the compensation cost statement. Doctors and hospitals must render monthly invoices; if the case is not completed, "the doctor is required to furnish an estimate of future charges necessary."

A card record listing each injury reported, its nature and cost is maintained for each employee. Compensation payments are entered on a payroll form which shows the employee's check number, name, occupation; date, nature and extent of injury; number of children under the age of 16; average weekly earnings, rate of compensation per week; amount of compensation award or settlement, amount previously paid, present payment and balance due. "A comparative statement," concluded Mr. Broadway, "is furnished our executives each month, showing the standing of the compensation department at each mine."

The accounting department's "control" over material expenditures, he stated in answer to a question by T. J. Thomas, president, Valier Coal Co., is limited to calling management's attention to costs which seem to be out of line. Most of the savings attributable to central warehousing, he told E. H. Johnson, Jeffrey Manufacturing Co., have come from reductions in inventory, standardization of materials stocked and the ability to make quantity purchases.

Coal producers caught between rising wages and a competitive market situation

W. J. Jenkins
Retiring president, Illinois Mining Institute

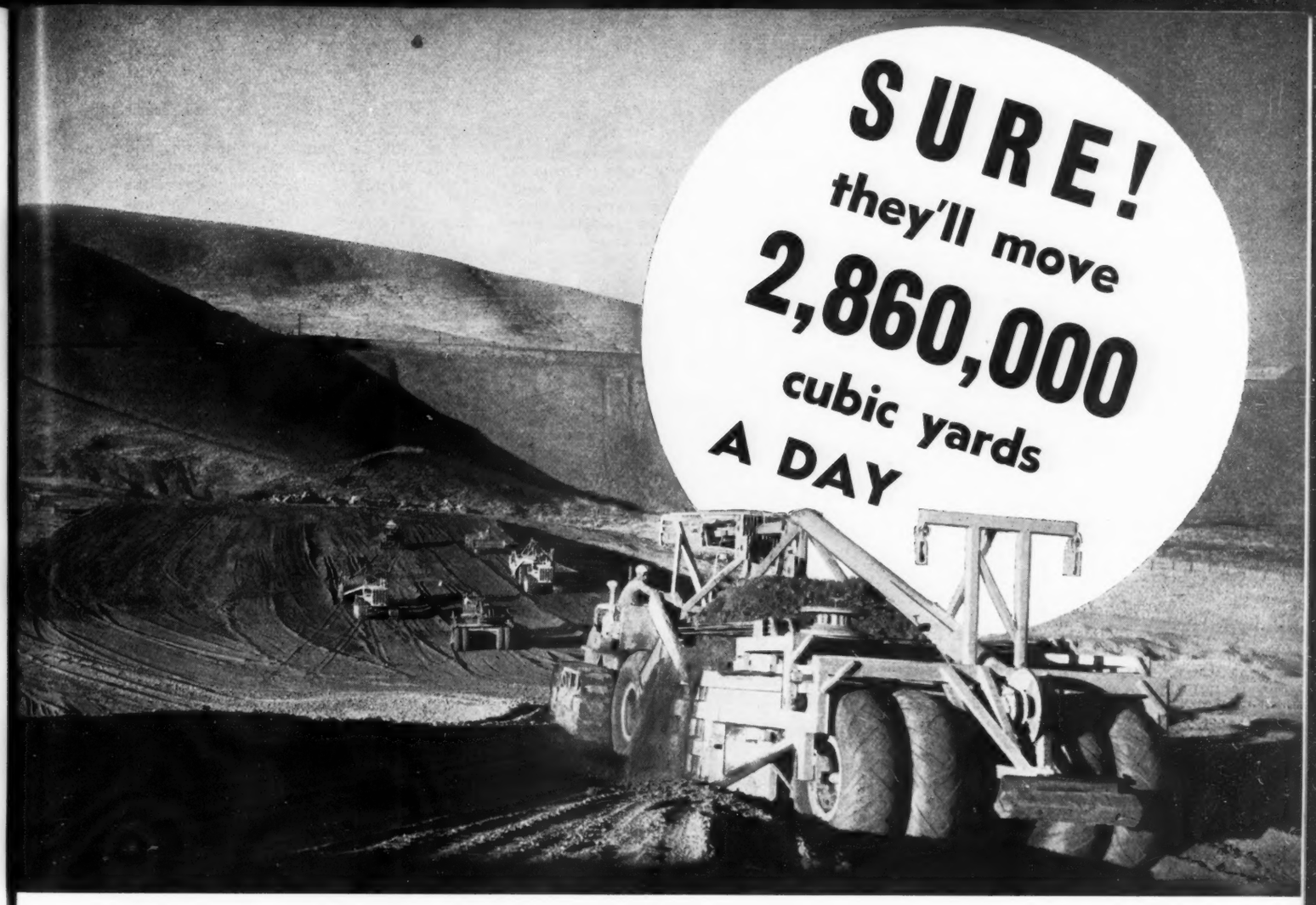
which generally prohibits passing the increases on to the consumer, said J. H. Fletcher, consulting engineer, have been compelled to seek lower costs through mechanization. Mid-Western strippers have been trail-blazers in this search. Beginning with inadequate equipment designed for the railroad and construction fields, these operators have demanded shovels which could handle greater and still greater overburdens. Strip-mine management also early realized the necessity for "balancing a unit organization so that it could function without loss of time." Multiple-shift operation has resulted in a "reasonable equipment cost" per ton of coal uncovered and has made modern stripping profitable.

Fletcher Discusses Trends

"The trend in the underground mining industry," asserted Mr. Fletcher, "apparently has been influenced by the open-pit practice. In changing from hand to mechanized loading, there has been an adjustment in all departments"—safety, mining systems, transportation, power supply and face preparation, as well as the actual loading. With modern methods and greater mechanization, management has become more aggressive in promoting safety. Formerly operators attempted to fit mechanization to mining systems developed for hand loading; "present activity in engineering departments throughout the country indicates that the managements have at last decided to revise their systems to fit mechanical loading."

Multiple-shift operation and increasing power demands have so improved the load factor, continued the speaker, that "it is very difficult, if not impracticable, for the public-service companies to compete with local mine-station-generated power." Improvements in power-plant equipment and practices make it appear that coal companies in many localities "will soon find themselves in the power-generating as well as the mining business."

Increase in capacity of loading equipment has been reflected in improvement in auxiliary and complementary equipment. Cutting-machine capacity has been stepped up, and Mr. Fletcher cited one case where a 12-ft. cutter bar was being used successfully



Cheaper excavation! Lower cost materials moving! Speed — more speed! The equipment *must* permit a profit; finish contracts on schedule! The echo of contractors' demands of Le Tourneau is heard the world over.

Le Tourneau factories are doing their utmost to fill these needs — twenty-four hours each weekday. Ahead of the Carryall Scraper that rolls out of the factory and onto the job today are 2,344 other Le Tourneau Carryall Scrapers. Enough to move 2,860,000 cubic yards* of earth and rock in a 22-hour day. 1,044 more Le Tourneau Scrapers than there were one year ago. And there are enough other Le Tourneau units — Angledozers, Bulldozers, Buggies and Rooters — to double that figure. They're cutting costs, speeding projects, both large and small, to a profitable conclusion.

See for yourself what Le Tourneau equipment will do. It's working day in, day out — in mud, gumbo, sand and rock. Blistering heat and sub-zero cold affect this rugged, all-weather equipment's operating economies but little. Part of the reason lies in the Le Tourneau principle of cable control on all equipment. Its trigger-quick action gives split-second positive control regardless of temperature or weather. Stout construction of the finest alloy steel, welded into one piece *keeps* Le Tourneau units on the job constantly producing results — and profits.

Watch it work! There's a Le Tourneau fleet owner near you. Compare their operating costs. Actual Job Data, certified for accuracy is available. Ask your Field Engineering Department for job studies similar to your undertaking. Or see your "Caterpillar" Dealer for a demonstration.

**Based on a very conservative average of 50 pay yards hourly on a 1,000-foot one-way haul.*

ACTUAL JOB DATA

REMOVING OVERBURDEN at the rate of more than 100 cubic yards hourly over a 600-foot round trip haul for Nugget Coal Co., Hanna, Wyoming. One Le Tourneau U-12 Carryall Scraper and "Caterpillar" RD8 tractor combination, with one operator, removed overburden varying from 6 to 30 feet in depth, from a 24 to 30-foot coal vein; permitted the company to keep its dragline constantly employed on productive coal loading. In addition, the tractor-Scraper combination found plenty of time to keep spoilbanks removed.

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Manufacturers of: Angledozers*, Buggies*, Bulldozers, Carryall* Scrapers, Cranes, Drag Scrapers, Rooters*, Power Control Units

*Name Registered U. S. Patent Office

on a shortwall machine in 32-in. coal in the Elkhorn field. Demand for a reduction in car-changing time in mechanical loading has led to larger-capacity rolling stock; heavier cars and track-mounted loaders and cutters have widened the use of heavier rail, special frogs and switches, and steel or composite ties.

Although market demand for large lump may be diminishing, buyers are not eager to absorb "the lower brackets of screening sizes" at production cost or to accept a car of prepared coal with an increased percentage of undersize. So face preparation is still an important problem. Permissible explosives, carbon dioxide and compressed air have demonstrated that they can be used in controlled shooting during the working shift "without danger to the employees in the territory and without smoke nuisance." Such shooting, added Mr. Fletcher, "is now permitted in the majority of the coal fields and it is hoped Illinois mines will be allowed to follow the trend."

Business, declared C. A. Reed, director, engineering department, National Coal Association, informally discussing the subject matter of a formal paper which he did not read, is interested in results—not products. The world is going modern fast and new homes bristle with automatic gadgets. Oil and gas early saw the possibilities of serving this new market; coal, too, must modernize its selling methods, think less of competition with itself and more of presenting a united industry front in the battle of fuels. Operating departments must be keyed to give the refinements in product which the automatic-minded consumer demands as the price of his patronage.

Coal producers may brag about the B.t.u. in their product, but the consumer—industrial or household—is looking for satisfaction in his plant and that is what the industry must sell him if it wishes to hold its place in the national energy market. Fortunately, according to Mr. Reed, coal men have awakened to this situation and are now working as a group to push their wares just as the walnut growers, the citrus-fruit groups and other organizations have done and are doing. Acting first with the stoker manufacturers and now independently, the National Coal Association is sponsoring campaigns to tell the story of coal both to the domestic and to the industrial market.

Enthusiastic Response to Campaign

Part of this drive is a campaign to educate the architect and the builder in proper basement layouts for the home. This has aroused not only the interest of those groups but of others, and some of the advertising efforts have stimulated editorial discussion and stories in daily newspapers as well as in trade publications. In the past three months, stated Mr. Reed, over 1,000,000 pieces of advertising literature have been distributed through producers, retail dealers and allied channels. The campaign is directed both to the modernization of existing hand-fired plants using large coal and to stoker installations in houses which might otherwise swing to competitive fuels.

Studies of the burning behavior of two coals from the same mine were shown in motion pictures by L. C. McCabe, Illinois State Geological Survey. One coal was high in vitrain; this coal swelled excessively, formed coke trees and developed bad blowholes in the stoker. The second coal, high in clarain, burned much more evenly, showed no excessive swelling or coke trees and was free from bad blowholes.

Coal men have acted cooperatively in the solution of their operating problems, declared George W. Reed, vice-president, Peabody Coal Co., and chairman of District Board No. 10, but there has been too little evidence of such cooperative action on the sales side. A large part of the responsibility for the ills of the industry must be laid at the door of its sales departments. The coal-control law enacted this spring, he added, is an attempt to remedy these ills and put the industry upon a firm and profitable foundation. If the act works, it means a new day in merchandising and the end of the order-taker.

Outlining the salient provisions of the law, Mr. Reed expressed the opinion that the section making it possible for injured operators to collect triple damages where injustice is done will have a far greater restraining influence upon unfair tactics than the 19 per cent tax levied against non-code members. In view of the fact that it took the Interstate Commerce Commission about two years to really get under way after the 1906 amendments to the act to regulate commerce, he counseled patience with the National Bituminous Coal Commission in its efforts to work out the solution to some very complicated problems. The new law, he added, could be a great help in promoting research; one project which appealed greatly to him was the use of powdered coal for diesel engines.

W. J. Jenkins, president, Consolidated Coal Co., and retiring president of the institute, reported that the membership of the organization was the greatest in its history. The total as of Nov. 1, said B. E. Schonthal, secretary-treasurer, was 597. Mr. Schonthal also stated that the financial condition of the institute was sound, with all bills paid and a reserve of cash and securities approximating $10,000. A letter report from John E. Jones, safety director, Old Ben Coal Corporation, and chairman of a special committee on appropriations for the U. S. Bureau of Mines, brought the news that, as the result of protests against reduced budgets, the safety division of the Bureau had escaped the Congressional axe and was functioning normally.

Following a brief talk by James W. Bristow, executive vice-president, Illinois Reciprocal Trade Association, warning the coal men that the State Highway Department was planning to install oil or gas boilers in buildings erected by it, the institute decided to appoint a committee to protest such a policy to Governor Horner. The personnel of this committee, appointed at the end of the business session, was: R. J. Sandoe, mining engineer, Perry Coal Co.; G. Stuart Jenkins, general superintendent, Consolidated Coal Co.; and T. J. Thomas, president, Valier Coal Co. Paul Weir, consulting engineer, offered an amendment to the bylaws, to be acted on at the June, 1938, meeting, to provide for the election of four members of the executive committee for a term of four years at each annual meeting. At present the entire board is elected annually to serve for one year. During the transition period, four members would be chosen for the full term, four for two years and four for one year.

At the Helm

Herbert H. Taylor, Jr., vice-president, Franklin County Coal Corporation, was elected president of the Illinois Mining Institute at its 45th annual meeting, at Springfield, Ill., last month. Paul Weir, consulting engineer, was chosen as vice-president, and B. E. Schonthal, president, B. E. Schonthal & Co., was again elected to the post of secretary-treasurer.

Members of the executive committee elected at the same meeting were: R. L. Adams, general superintendent, Old Ben Coal Corporation; W. C. Argust, division superintendent, Peabody Coal Co.; C. F. Hamilton, vice-president, Pyramid Coal Corporation; Carl T. Hayden, vice-president and general manager, Sahara Coal Co.; M. M. Leighton, chief, Illinois State Geological Survey; James McSherry, director, Illinois Department of Mines and Minerals; F. S. Pfahler, president, Superior Coal Co.; C. J. Sandoe, vice-president, Perry Coal Co.; L. D. Smith, vice-president, Chicago, Wilmington & Franklin Coal Co.; T. J. Thomas, president, Valier Coal Co.; Louis Ware, president, United Electric Coal Cos.; and William P. Young, vice-president and general manager, Bell & Zoller Coal & Mining Co.

★ ★

Mine Fire Beneath Scranton

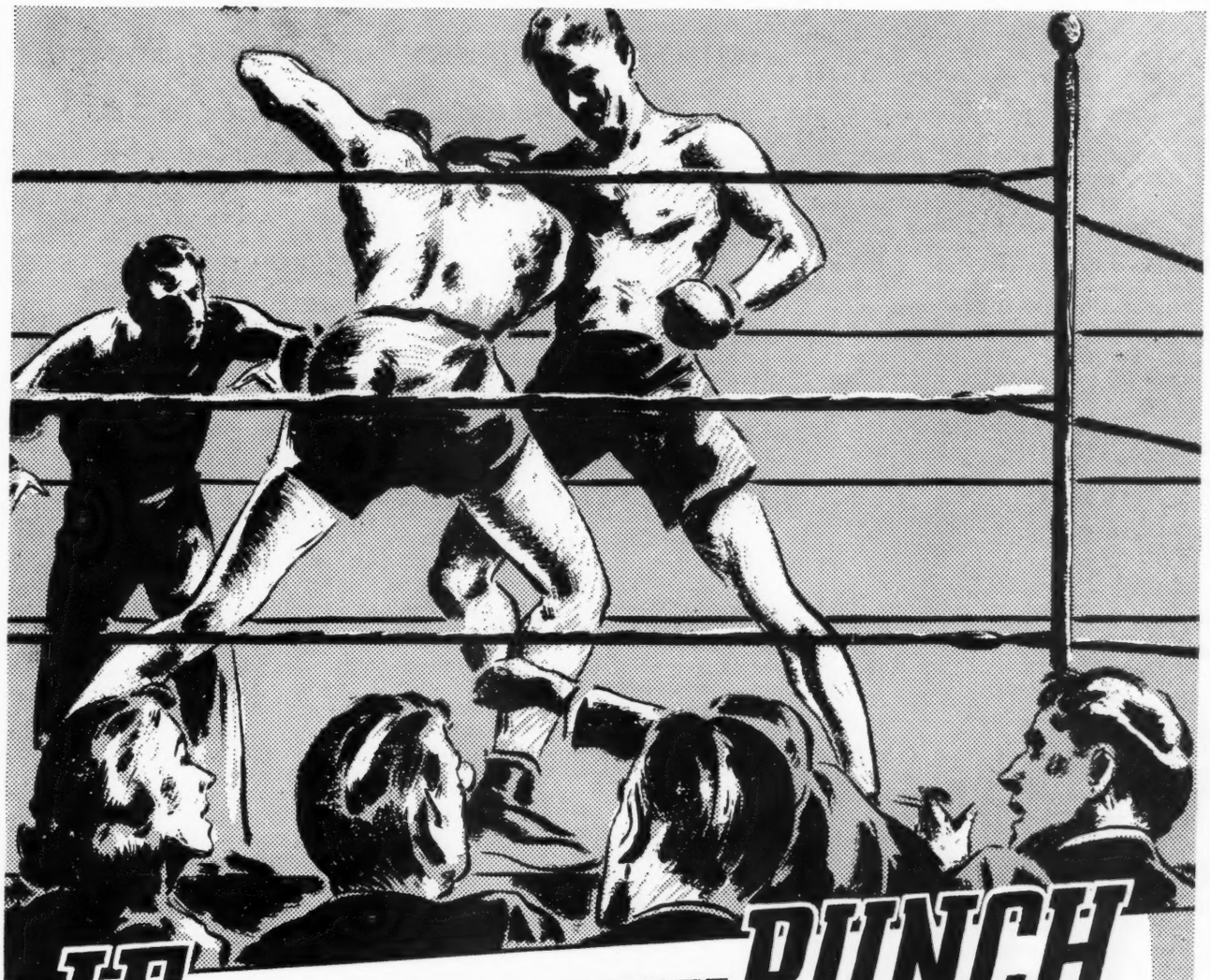
A mine fire beneath Scranton, Pa., in a section inhabited by about 10,000 persons which had engineers in a quandary for several weeks was believed to be under control, it was reported on Nov. 12. The blaze is said to have originated from a broken trolley wire on Oct. 27 in the Von Storch mine of the Penn Anthracite Collieries Co., 250 ft. beneath the surface. Mine inspectors said that the blaze had been confined to an area 100 ft. square, and W.P.A. engineers planned to press men on their rolls into service in fighting the fire.

Obituary

FRANK E. LEARNED, 57, vice-president in charge of operations, Philadelphia & Reading Coal & Iron Co., died Oct. 23 of a heart ailment at his home in Merion, Pa. Graduated in 1905 from the University of Maine with an electrical engineering degree, he was associated for some years with Stone & Webster, Inc.; for the last ten years he had been with P. & R., first as assistant to the president and then as vice-president.

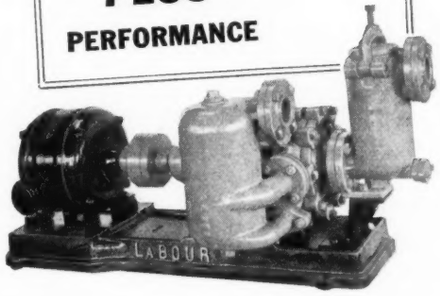
DOWNIE D. MUIR, JR., president, United States Fuel Co., subsidiary of the United States Refining, Smelting & Mining Co., of which he was vice-president, died at Boston, Mass., on Oct. 23 at the age of 53. He had been connected with the organization for 22 years, 15 in the Salt Lake City (Utah) office as general manager and vice-president.

DAVID A. BROWN, 49, general superintendent, Spring Canyon Coal Co., operating in Carbon County, Utah, and president



IF HE COULD ONLY PUNCH

CORROSION RESISTANCE
PLUS
PERFORMANCE



• He can take punishment—plenty—but he'll never be a champion. He simply can't hit hard enough to get results.

There are mine pumps like this prize fighter. They resist corrosion, but they are costly to operate because they are weak on performance.

Mere corrosion resistance isn't enough. When you buy or specify pumps, consider *two* counts. You'll find plenty of prospects to meet your corrosion requirements, but only LABOUR can give you that important other factor—operating performance due to LABOUR specialized design.

Ask us to send complete details about the application of LABOUR Pumps to your problems. There's no cost or obligation involved.

LABOUR PUMPS

THE LABOUR COMPANY, INC.
ELKHART, INDIANA

of the Rocky Mountain Coal Mining Institute, died suddenly Oct. 31 of a heart ailment. He had been with the Spring Canyon company for the last fourteen years, the first eight as assistant superintendent and the last six as general superintendent. He was elected to head the Rocky Mountain institute last spring.

JOHN H. MARTIN, 63, president and general manager of the Bear River Coal Co., Evanston, Wyo., and president of the Scofield Coal Co., operating in Carbon County, Utah, died Nov. 2 at his home in Evanston, Wyo., following an illness lasting a year.

JOSEPH DICKSON EDDY, 42, partner in the firm of Dickson & Eddy, anthracite producers and distributors, with headquarters in New York City, died Nov. 5 in that city. He was a captain of infantry during the World War, serving in many major offensives and holding the Belgian Croix de Guerre with palm.

WILLIAM F. HAYDEN, 67, well-known Colorado coal operator, died Nov. 3 at his home in Denver. Born in Milwaukee, Wis., he went to Colorado 32 years ago. He was president of the Charter Oak Coal Co., Colorado-Routt Coal Co. and George Land Co., and was associated with the Hayden Brothers Coal Co.

Two Collieries Reopened

Morea and New Boston collieries, formerly operated by the Mill Creek Coal Co., a subsidiary of Madeira, Hill & Co., in Schuylkill County, Pennsylvania, which were closed when the company filed a petition in bankruptcy last August, resumed work Nov. 16 with 600 employees. The plants are being operated by the Morea Coal Co., headed by Tony Rose, Pittston.

New Preparation Facilities

CULGUN COAL CO., Amsterdam, Ohio: contract closed with Morrow Mfg. Co. for three-track screening unit with loading booms, etc., for stripping operation; capacity, 125 tons per hour.

EASTERN COAL CORPORATION, INC., Mine No. 1, Hardy, Ky.: contract closed with Morrow Mfg. Co. for rescreening plant for 2½x0-in. coal, including double-deck vibrating screens, conveyors and auxiliary equipment; capacity, 200 tons per hour.

STANDARD BRAZIL BLOCK COAL CO., Clay City, Ind.: contract closed with Morrow Mfg. Co. for rescreening plant for 2x0-in. coal, including double-deck vibrating screens, conveyors and auxiliary equipment; capacity, 80 tons per hour.

TRUAX-TRAER COAL CO., Fiatt mine, Fiatt, Ill.: contract closed with the McNally-Pittsburg Mfg. Corporation for a washing-plant addition to present plant to clean 6x0-in. coal in two McNally-Norton automatic washers with a combined capacity of 500 tons per hour and classify into six sizes; to be completed about March 1, 1938.

GLEN ALDEN COAL CO., Audenried (Pa.) colliery: installation of four 8-ft. Menzies cone separators for cleaning pea, buckwheat, rice and barley now under way; total feed capacity, 280 tons per hour.

LACKAWANNA & WYOMING VALLEY RAILROAD CO., Moosic, Pa.: contract closed with the Finch Mfg. Co. for 5-ft. Menzies cone separator for cleaning No. 4 buckwheat; capacity, 40 tons per hour.

Action on Minimum Coal Prices Speeded With Average Output Costs Set

WASHINGTON, D. C., Nov. 15—Noteworthy progress in the work of setting minimum prices under the bituminous coal control law has been shown by the National Bituminous Coal Commission in the last few days with the announcement of weighted average costs of bituminous production in nine minimum price areas and a decision that intrastate shipments of Ohio coals are subject to the provisions of the act. Weighted averages have been set for the following price areas: No. 1, $2.15 per net ton; No. 2, $1.79; No. 3, $2.55; No. 4, $3.59; No. 5, $2.02; No. 6, $2.74; No. 7, $2.46; No. 9, $2.11; No 10, $3.45. These areas include all the minimum price areas except No. 8, embracing substantially North and South Dakota, which produce coal of the lignite variety, but the Commission has not yet determined whether lignite is in fact bituminous coal under the terms of the coal act.

On the basis of these determinations the Commission will proceed to the proposal and coordination of minimum prices among the various producing districts. The work should be completed and minimum prices in effect between Dec. 10 and 15, according to Chairman Hosford, of the Commission, who made this prediction in connection with an announcement of his resignation on Nov. 3. After a conference on Nov. 12 with James Roosevelt, secretary to the President, Mr. Hosford announced the withdrawal of his resignation.

The work of coordinating minimum prices for Districts 1, 2, 3, 4, 5, 6, 7 and 8, comprising Minimum Price Area No. 1 and embracing the entire Appalachian field except Alabama, was taken over by the Commission on Oct. 22. This action was taken to expedite the establishment of minimum prices, representatives of the districts involved having admitted that they had been unable to conclude the work. Representatives of Districts 2 and 3 (western Pennsylvania and northern West Virginia), with a tonnage of 93,000,000 annually, proposed that the Commission exercise its authority to take over the work. D. T. Buckley, chairman of District Board 3, declared that while delays continued in the hopeless efforts of the boards to propose voluntary prices, slack coal costing $1.25 to produce was selling at 65c per ton. Chairman Hosford, of the Commission, said, "the industry cannot be stabilized until minimum prices are made effective and undue delays undoubtedly serve only to impair further the status of many code member producers."

Among the reasons given for the Commission's decision were:

1. Unwillingness of some groups of producers to make disclosures on distribution from their districts.
2. Insistence by others that the statute contemplates allocation of tonnage.
3. Demands that tonnages of previous years be completely preserved to districts without regard for any other interest or factor.
4. Wide variance of opinion as to the purposes of the coal act and the interpretations to be given its various provisions.
5. Utter inability to agree upon the weight to be accorded each factor or standard prescribed by the law for use in price determinations.
6. Insistence that fundamental differences and conflicts in the industry be immediately and permanently settled without any experience gained from operation of the price provisions of the act.
7. A proposed price structure so complex that failure of any two groups to arrive at an agreement delays and often prevents action by other groups.

Ohio Coals Come Under Act

Outstanding importance was given to the order by the Commission, issued Nov. 11, that all bituminous coal sold in intrastate commerce in Ohio shall be subject to the coal act, effective Dec. 15. The decision, which was unanimous, held that substantially all intrastate transactions in Ohio coal affect interstate commerce, and that if intrastate coal were not regulated it would impose undue, unreasonable or unjust discrimination against interstate coal.

In late years, according to an opinion accompanying the order, prices realized by producers have not, on the average, equaled production costs, and radical changes have taken place in methods of distribution, including widespread use of motor trucks, which have "broadened immeasurably the markets available to any individual mine or producing district." Transformations also have occurred in uses, the opinion continues, putting producers under constant stress to find outlets for particular sizes not in immediate demand. Other factors considered were the broadened markets of industries depending upon coal for energy and the competition of other fuels and forms of energy.

"It may therefore be concluded," said the opinion, "that in general the production and distribution of coal has ceased to be an activity local in effect, and that commerce in coal cannot any longer be dealt with as a business activity limited in scope to areas within the confines of a single State. We find no line of distinction between persons, mines, and producing fields engaging in intrastate commerce in the State and those engaging in interstate commerce, nor do we find that any particular size, grade or quality of coal can be ear-marked for movement into other States. Neither the cost

★ ★

PERMISSIBLE PLATES ISSUED

THREE approvals of permissible equipment were issued by the U. S. Bureau of Mines in October, as follows:

Brown-Fayro Co.: Type HGD room hoist; 5-hp. motor, 230-500 volts, d.c.; Approvals 329 and 329A; Oct. 2.

Joy Manufacturing Co.: Type C-536 1F slate-cutting machine; 100-hp. motor, 500 volts, d.c.; Approval 330A; Oct. 22.

Goodman Manufacturing Co.: Type 724-CJ slate-cutting machine; 100-hp. motor, 500 volts, d.c.; Approval 331A; Oct. 28.

This WORLD'S LARGEST TANDEM

Hauls 50 to 54 Tons *Each Trip* WITH ONE TRUCK

● The largest tandem trail cars ever built have just gone into service for United Electric Coal Companies. In terms of cost per ton mile these haulage units are probably the lowest cost automotive coal units ever built.

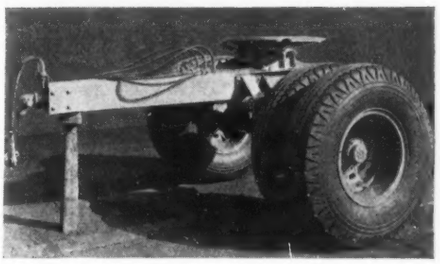
Each trail car holds 33 cubic yards level full, and is built from the ground up to take the terrific impact of big shovel loading—the hammering jolts of travel over rough mine roads. The specially designed heavy duty solid steel axles, cast steel wheels, over-capacity springs, two way oscillating fifth wheel, enable the driver to put this triple tonnage hauling unit over the road safely without spillage or sidesway—give it the endurance and reliability of the "Western" railroad dump car.

Air operated clamshell doors controlled from the cab, enable the driver to dump each load separately at the desired location. With full door clearance the tandem can also be used for handling gob on the return trip, dumping on the ground wherever the material is needed for highway maintenance.

There are more Austin-Western trail cars used in open pit coal mines today than any other make of semi-trailer. Their performance records during years of service have already proved the value of "Western" dump car experience in designing pneumatic tired trail cars that are low in operating and upkeep costs.

Whatever your special requirements, Austin-Western engineers have the experience and the ability to give you the kind of haulage unit you require. Write us for complete performance and engineering details.

This single 25 ton trail car, similar in design to the new tandems, is one of a fleet of A-W haulage units owned by the Central State Collieries. Repeat orders from this company prove their economy and satisfaction.



The dolly shown here supports the front end of the rear tandem unit. Thus the tandem can be operated as single trail car units where desired.

Austin-Western

THE AUSTIN-WESTERN ROAD MACHINERY CO.
1810 Barrows St., Aurora, Illinois

Please send me your Trail Car Bulletins.

Name.....

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State..... TC796

nor method of producing and preparing coal determines its market within or without the State. Coal is produced and loaded at the mine for shipment without regard to its ultimate destination, which is determined entirely by marketing factors."

With the withdrawal on Oct. 30 of objections by a number of large producers, Commission examiners accepted into evidence a plan of classification for Illinois coals presented by Howard W. Vesey in behalf of the Northern Illinois Coal Co., Little John Coal Co., Midland Electric Coal Co., Truax-Traer Coal Co., United Electric Coal Cos., Galesburg Mining Co. and Central States Collieries. The plan proposed subdividing Illinois coals by districts and seams, by mines; by ash and sulphur content; by friability and heat and moisture content; by weatherability, ash-softening temperature and ash analysis; and by volatile matter and carbon content.

Acceptance Ends Controversy

Dr. Clayton G. Ball, consulting engineer and geologist, explained that the State's coals might be fitted into the classification scheme in a manner more or less simple as the Commission might determine when it came to setting prices. Hubert Howard, president, Binkley Coal Co., as spokesman for the Old Ben Coal Corporation, Wasson Coal Co., Franklin County Coal Corporation; Chicago, Wilmington & Franklin Coal Co., Consolidated Coal Co., Bell & Zoller Coal Co. and subsidiaries; Peabody Coal Co., Panther Creek Mines, Inc.; Central Illinois Coal Mining Co., Mine B Coal Co. and the Belleville Group Coal Association, as well as his own company, conceded that the producers he represented favored the plan as a good framework from which to complete the work of classification. Acceptance of the plan brought to an end a lengthy controversy during the course of which an order was issued taking the work of classification out of the hands of the State Producers' Board and directing the Commission's staff to complete it.

Thirteen witnesses testified at a two-day hearing on the application of the Guffey-Vinson coal act to Michigan coals, held Oct. 26 and 27 at Saginaw. Statistics offered by L. N. Plein, Commission marketing authority, tended to show that interstate coals penetrate into all markets within the State. Herbert W. Bean, sales manager, Robert Gage Coal Co., and chairman of District 5 Producers' Board, said that Michigan coal met competition with out-of-State coal at all its distributing centers and that absence of regulation under the federal law would be an advantage to Michigan producers. In his opinion, price would be the main consideration in competition with outside coal if Michigan coal were not regulated.

Corroboration of this testimony was offered by George C. Eastwood, president, Consolidated Coal Co., and a member of District 5 board. Walter Pippin, coal producer and secretary of District 5 board, pictured the steady decline of Michigan coal since 1920 and declared that regulation of the industry and the banning of price competition to the southward might result in increased activity on Lake Huron. "Intrastate transactions in coal as they affect interstate transactions," he concluded, "are so complicated that I see no chance of regulating one without regulating the other."

Evidence offered by at least three of the witnesses, who included representatives of various railroads and mining enterprises, revealed that it is the declared policy of the State of Michigan that locally produced coals are competitive in character with out-of-State coals and that it is obligatory for the heads of public institutions to use Michigan coal under certain circumstances where the price differential is such as not to be too great a burden upon the taxpayers. John F. Connor, assistant to the Commission's general assistant, declared that the evidence in the record showed that intrastate commerce in coal to all parts of the State should be subject to Sec. 4 of the coal act.

Unanimous agreement that the entire coal industry in Virginia must be regulated marked the hearing held by the Commission at Norton, Va., Oct. 26-30. Expected opposition from truck owners not only failed to develop but several of their representatives testified that to their belief it would stifle fair competition if only a part of the State's coal indusry were regulated. F. G. Tryon, chief of the Commission's market statistics division, brought out that even strictly intrastate coal, both mined and consumed within the State, frequently crossed State lines in transportation and that all of it was in direct competition from neighboring States. Sales managers from coal companies in North Carolina, West Virginia and Tennessee testified that they were in constant competition with intrastate Virginia coals.

A five-day hearing on the competitive relationship of coal produced in West Virginia and consumed therein to bituminous coal imported into the State was concluded Oct. 25 at White Sulphur Springs. Twenty-eight witnesses were called by the Commission and 68 exhibits showing the production and shipment of coal from contiguous districts were presented. All were in agreement that it would be impracticable for the Commission to attempt to regulate any substantial portion of West Virginia coal without regulating all coal produced and sold within the State.

Among the chief witnesses were F. G. Tryon, chief of the bureau of market statistics of the Commission; Dr. Stephen P. Burke, of District Board 3 and technical director for the Consolidation Coal Co.; Dr. Waldo E. Fisher, economist of the Wharton School of Finance, University of Pennsylvania; C. W. Shinnamon, executive secretary, District Board 3 (northern West Virginia), and William Blizzard, United Mine Workers. Robert Spillman, representing several Kanawha County coal producers, cross-examined most of the witnesses briefly.

Ruling on Contracts Issued

The Commission issued a ruling on Oct. 27 under which agencies of the federal and State governments might enter into contracts for the delivery of coal pending the establishment of minimum prices. The order was issued in view of the fact that in some instances governmental agencies are required by local statute to award contracts only after submission of bids. The awarding of such contracts was authorized provided they contained a clause stating that in the event the Commission established minimum prices during the period of the contract the contracted price would be increased, if necessary, to equal the minimum established by the Commission.

To learn whether consumers may be discriminated against in prices to be considered by the Commission at forthcoming hearings, John Carson, Consumers' Counsel of the Commission, announced today that as soon as proposed minimum price schedules are released by the Commission he will call a conference to discuss the prices to determine whether they are fair and to decide upon proper action to take at the hearings. Mr. Carson urges consumers to publicize the proposed conference and induce those "informed on coal prices to represent their interests at the conference and at the Commission's minimum price hearings." The conference, it is pointed out, will afford consumers an opportunity to present their views and to learn what other consumers think, the aim being to map out a program to follow in the presentation of consumer testimony at the hearings.

Earle Warns on Compensation

That anthracite operators would face unlimited court suits if they refused to pay higher compensation to injured workmen was the warning sounded on Oct. 30 by Governor Earle of Pennsylvania. The Legislature has passed a new compensation act, but left acceptance optional with the producers, a group of whom declared that they would reject the amended act.

"Whether they accept the act or not, they are going to be forced to pay compensation," said the Governor. "The only difference is that under the act the awards will be made according to a fixed scale by the Workmen's Compensation Board, whereas if they reject the act, every case can be taken into the courts, and the sky is the limit when the juries make the awards."

In rejecting the new act the objectors pointed out that "under the amendments to become effective with the new year are provisions which not only increase the costs of workmen's compensation more than 100 per cent but provide compensation for industrial diseases and require employers to pay the costs of administration on the part of the State."

Government Committee Named

Charged with making a study of important subjects during the next several months, the committee on public and government relations of the National Coal Association has been renamed, with some revision in personnel, by Heath Clark, president. Consideration will be given to the Guffey-Vinson coal act as well as to shorter working hours vs. higher wage scales in relation to the industry in general, and the committee will welcome suggestions in the study of these subjects.

The personnel of the committee is as follows: Charles O'Neill (chairman), president, United Eastern Coal Sales Corporation; C. E. Bockus, president, Clinchfield Coal Corporation; William G. Caperton, president, Smokeless Coal Corporation; C. C. Dickinson, president, Dickinson Fuel Co.; Milton H. Fies, vice-president, DeBardeleben Coal Corporation; J. D. Francis, president, Island Creek Coal Co.; George B. Harrington, president, Chicago, Wilmington & Franklin Coal Co.; George H. Love, president, Union Collieries Co.; Douglas Millard, manager of sales, fuel and byproducts division, Colorado Fuel & Iron Corporation; J. D. A. Morrow, president, Pittsburgh Coal Co.; W. C. Shank,

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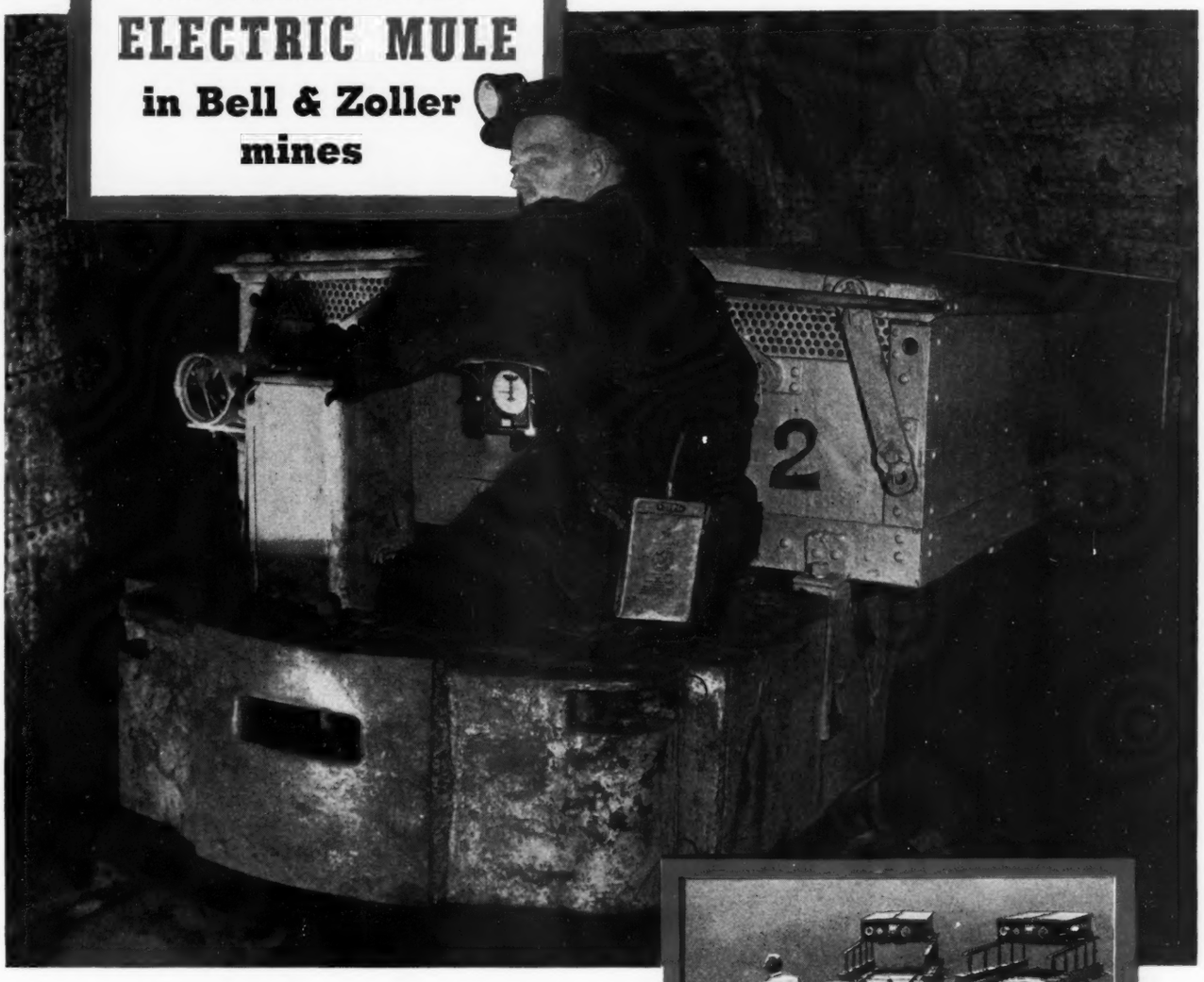
in Bell & Zoller mines



● Six 6-ton Mancha Storage Battery Locomotives are furnishing safe, efficient service in the famous Bell & Zoller No. 1 mine at Zeigler, Illinois.

Note that the motorman sits entirely inside the heavy cast steel frame. He is SAFE—he works efficiently.

For complete information on these locomotives and other Mancha products just write to the Mancha Storage Battery Locomotive Company, 4850 South Halsted Street, Chicago, Illinois.

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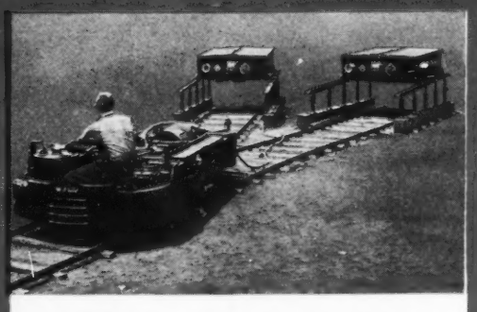

MANCHA TRANSFER RACK

Mancha transfer racks permit the motorman to change a discharged set of batteries for a fully charged set in three minutes, without manual labor. Two batteries are used — one is charged while the other is in service. This permits battery locomotives to be double or triple shifted.

The discharged battery is put on the rack at one side of the transfer switch and the locomotive trams to the other rack, by means of a cable, to pick up the freshly charged battery.

president, Crowe Coal Co.; R. H. Sherwood, president, Central Indiana Coal Co.; George K. Smith, president, Sunday Creek Coal Co.; C. W. Watson, president, Elk Horn Coal Corporation.

Experiment Plant Dedicated

The new Eastern Experiment Station, U. S. Bureau of Mines, at College Park, Md., was dedicated on Oct. 15 with Julian D. Conover, secretary of the American Mining Congress, presiding. There were addresses by Dr. John W. Finch, director of the U. S. Bureau of Mines; Dr. H. C. Byrd, president, University of Maryland, and Governor Harry W. Nice of Maryland. The station comprises a three-story main building 53x114 ft. with two two-story wings 50x113 ft. each and is adjacent to the University of Maryland campus.

N.C.A. to Tabulate Jobless

A count and tabulation of the unemployed in the soft-coal industry, independent of the general census of unemployed to be taken under government auspices, was ordered in a call on Oct. 28 by the National Coal Association upon secretaries of district associations and through them on all bituminous coal operators. The report, which will be as of Nov. 10, is to cover only miners and other workers in the coal fields who are able bodied and capable of employment but who are out of work at the time.

Island Creek Moves Office

General sales offices of the Island Creek Coal Co. were moved from Cincinnati, Ohio, to Huntington, W. Va., effective Nov. 1. The company and its affiliates have taken the sixth and seventh floors of the Robson-Prichard Building in the latter city. Distribution through the various branches will be directed from the main office, but otherwise the offices in Cincinnati, Ohio; Detroit, Mich.; Cleveland, Ohio; Richmond, Va.; Chicago, New York, Boston, Mass., and Toronto, Ont., will be undisturbed.

Industrial Notes

HERCULES POWDER CO. has appointed Harry F. Kolb as director of purchases to succeed Ralph B. McKinney, who has been assigned to special duties with the paper makers' chemical division of the company. Mr. Kolb, who has been assistant manager of the company's San Francisco office will assume his new duties in Wilmington, Del., about Dec. 1.

ROOTS-CONNERSVILLE BLOWER CORPORATION, Connersville, Ind., has made F. W. Allen & Son, Erie, Pa., its representatives in the counties of Pennsylvania and Ohio adjacent to that city.

LINCOLN ELECTRIC CO., Cleveland, Ohio, has appointed Arthur T. Cox, Jr., as manager of its Tri-Cities office, Moline, Ill. He succeeds J. B. Flock, absent on leave. A new sales office has been opened in Phoenix, Ariz., in charge of R. J. Reardon. Robert H. Schuster has been appointed to the sales staff of the Pittsburgh (Pa.) office.

ELECTRIC HOSE & RUBBER CO., Wilmington, Del., has opened a new Eastern sales office at Room 919, 9 Rockefeller Plaza, New York City, which will be the headquarters of A. B. Dougall, general sales manager, and D. C. Smalley, manager of the Metropolitan sales division.

MORRIS MACHINE WORKS, Baldwinsville, N. Y., manufacturer of centrifugal pumps and hydraulic dredges, has appointed the Lang Co., 267 West First St., Salt Lake City, Utah, as representative in that territory.

Pickets Resume at Marissa

Picketing was resumed on Nov. 9 at the Okay operation of the Marissa Coal Co., near Marissa, Ill., by 30 members of the Progressive Miners. This move followed the action of Circuit Judge Maurice V. Joyce in modifying an injunction to permit "peaceful picketing" on Nov. 5. The operation is manned with a crew recruited from the United Mine Workers.

Coal-Mine Fatality Rate Recedes Further

Accidents at coal mines of the United States caused the deaths of 70 bituminous and 11 anthracite miners in September last, according to reports furnished the U. S. Bureau of Mines by State mine inspectors. With production totaling 38,620,000 tons, the death rate among bituminous miners was 1.81 per million tons, compared with 2.62 in the preceding month, when 33,984,000 tons was produced, and 2.88 in September, 1936, when output was 37,192,000 tons.

The anthracite fatality rate in September last was 3.14 per million tons, based on a production of 3,507,000 tons, as against 3.87 in the preceding month, with an output of 2,584,000 tons, and 3.10 in September, 1936, in mining 3,874,000 tons.

For the two industries combined, the death rate in September last was 1.92, showing a pronounced decline from the preceding month, when the figure was 2.62, as well as from that for September, 1936, which was 2.90.

Fatalities during September last, by causes and States, as well as comparative rates for the first nine months of 1936 and 1937, by causes, are given in the accompanying tables.

COAL-MINE FATALITIES, SEPTEMBER, 1937, BY CAUSES AND STATES

State	Underground: Falls of roof	Haulage	Explosive	Electricity	Mining machines	Other causes	Total underground	Shaft	Surface	Grand total
Alabama	1	.....	.....	.....	.....	.....	1	.....	.....	1
Colorado	.....	.....	.....	1	.....	.....	1	.....	.....	1
Illinois	3	2	.....	.....	.....	1	6	.....	.....	6
Indiana	1	1	.....	.....	.....	.....	2	.....	.....	2
Iowa	1	.....	.....	.....	.....	1	2	.....	.....	2
Kentucky	11	2	.....	.....	.....	.....	13	.....	.....	13
Maryland	.....	.....	.....	.....	.....	.....	.....	.....	1	1
Ohio	4	3	.....	1	.....	.....	8	.....	.....	8
Penn (bit.)	5	3	.....	2	1	1	12	1	.....	13
Utah	1	1	.....	.....	.....	.....	2	.....	.....	2
Virginia	2	1	.....	.....	.....	.....	3	.....	.....	3
West Virginia	8	7	.....	1	.....	1	17	.....	.....	17
Total (bit.)	37	20	.....	5	1	4	67	1	2	70
Penn. (ant.)	6	2	1	.....	.....	2	11	.....	.....	11
Total, Sept. 1937	43	22	1	5	1	6	78	1	2	81

FATALITIES AND DEATH RATES AT UNITED STATES COAL MINES, BY CAUSES*

January—September, 1936 and 1937

Cause	Bituminous: Number Killed 1936	1937	Killed per Million Tons 1936	1937	Anthracite: Number Killed 1936	1937	Killed per Million Tons 1936	1937	Total: Number Killed 1936	1937	Killed per Million Tons 1936	1937
Falls of roof and coal	434	394	1.432	1.206	98	93	2.398	2.558	532	487	1.547	1.342
Haulage	129	172	.426	.527	17	21	.416	.578	146	193	.424	.532
Gas or dust explosions:												
Local explosions	15	10	.050	.031	11	...	.269	.....	26	10	.076	.027
Major explosions	18	47	.059	.144	5	...	.122	.....	23	47	.067	.129
Explosives	18	20	.059	.061	13	10	.318	.275	31	30	.090	.083
Electricity	26	40	.086	.122	6	2	.147	.055	32	42	.093	.116
Mining machines	11	11	.036	.034	...	...	.....	.....	11	11	.032	.030
Other machinery	9	5	.030	.015	2	1	.049	.027	11	6	.032	.017
Miscellaneous:												
Minor accidents	31	28	.102	.086	17	9	.416	.248	48	37	.139	.102
Major accidents	9	...	.030	.....	...	...	.....	.....	9	...	.026	.....
Shaft	6	12	.020	.037	7	3	.171	.082	13	15	.038	.041
Stripping or open-cut	7	5	.023	.015	7	5	.171	.138	14	10	.041	.027
Surface	28	44	.092	.135	12	13	.294	.358	40	57	.116	.157
Grand Total	741	788	2.445	2.413	195	157	4.771	4.319	936	945	2.721	2.603

* All figures subject to revision.

● "Sure it costs a little more—but listen: the increased service you will get out of LAY-SET Preformed will more than justify the slight differential in first cost. For instance:

"Your men can reeve LAY-SET in place and get your machine back into profitable production in about half the time they would spend on non-preformed. Then, with LAY-SET, your machine will have much longer continuous operation—because LAY-SET will last longer.

"If LAY-SET Preformed wears out to the point where the crown wires part—they won't wicker out to jab workmen's hands. It's a safe rope to handle. It resists kinking; almost refuses to whip and spools on the drum perfectly. Being preformed it resists the fatigue of reverse bending. Believe me, sir (and we've been in business for 91 years) LAY-SET Preformed is a much better rope."

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AMERICAN CHAIN & CABLE COMPANY, Inc.
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Chain Hoists • Electric Hoists and Cranes

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ALL HAZARD WIRE ROPES MADE OF IMPROVED PLOW STEEL ARE IDENTIFIED BY THE GREEN STRAND

STANDARD

This 50 hp. trolley locomotive motor in Bell & Zoller's famous No. 1 Mine at Zeigler, Ill., has just been completely overhauled, Rockbestos A.V.C. Mining Cable replacing the original leads.

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Locomotives—Loaders and Mining Machines in BELL & ZOLLER MINES

• Bell & Zoller's five great Illinois mines are so highly mechanized—operate with such machine-like precision that, so far as is humanly possible—breakdowns of electrically operated mining machinery *must be prevented.*

• One of their most effective precautions is the general use of ROCKBESTOS A.V.C. Mining Cable for rewiring locomotives, loading machines and mining machines. Experience has shown that no other type of cable is so dependable for motor, resistor and controller connections—so resistant to heat, oil, and other coal mining conditions which soon break down ordinary insulation—causing short circuits and consequent failures.

Follow the example of this recognized leader. Prevent breakdowns, and keep up production schedules, by wiring your machines with ROCKBESTOS A.V.C. All of the jobbers listed below carry ample stocks. Order from them, or from Rockbestos Products Corporation, New Haven, Connecticut.

ROCKBESTOS A.V.C. MINING CABLE JOBBERS

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BECKLEY MACHINE & ELEC. CO., Beckley, W. Va.
FAIRMONT SUPPLY CO., Fairmont, W. Va.
IRON CITY ELECTRIC CO., Pittsburgh, Pa.
MINE SERVICE CO., INC., Lothair, Ky.
MOORE-HANDLEY HARDWARE CO., Birmingham, Ala.
PENN ELEC. ENGINEERING CO., Scranton, Pa.
ROGAN & ROGAN CO., Middlesboro, Ky.
SUPERIOR-STERLING CO., Bluefield, W. Va.
WILLIAMSON SUPPLY CO., Williamson, W. Va.
EVANSVILLE ELECTRIC & MANUFACTURING CO., Evansville, Ind.
NATIONAL ELEC. COIL CO., Bluefield, W. Va. Columbus, Ohio
UPSON-WALTON CO., Cleveland, Ohio Pittsburgh, Pa.

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SAN FRANCISCO 367 Ninth St.
In ENGLAND—British Insulated Cables, Ltd. Prescot, Lancashire
CLEVELAND 1749 Union Trust Bldg.
CHICAGO 847 Marquette Bldg.
PITTSBURGH—2137 Koppers Bldg.
SEATTLE 1714 First Ave., So.
PORTLAND, ORE. 209 S.W. First Ave.
In CANADA—Phillips Electrical Works, Ltd. Montreal, Que. and Brockville, Ont.

One of Bell & Zoller's 93 mining machines—all of which are wired with Rockbestos A.V.C., their standard for replacement.

Bell & Zoller's 34 Loading Machines are all wired with Rockbestos A.V.C. Mining Cable.

Rockbestos A.V.C. Mining Cable is used exclusively for rewiring Bell & Zoller's 127 Electric Locomotives.

A·V·C· THE WIRE WITH PERMANENT INSULATION

ROEBLING

Trolley & Contact Wire

ROUND SECTION
Style 1: Made in sizes 4/0 to 1/0 A.W.G.
AMERICAN STANDARD GROOVED SECTION
Style 2: Made in sizes 350,000 circular mils to 2/0 A.W.G.

ALSO AT YOUR SERVICE—

To meet coal mine requirements Roebling makes available a comprehensive variety of high quality electrical wires and cables, including Mine Locomotive Cable » Weatherproof Wire » Telephone Wire » Concentric and Duplex Mining Machine Cable » Mine Entry Cable » Bore Hole Cable » Rubber Covered Wires and Cables; Braided and leaded, and many types for special purposes.

We invite your inquiry for further information, samples or prices.

JOHN A. ROEBLING'S SONS COMPANY, TRENTON, N.J.

Branches in Principal Cities

Both copper and bronze Trolley or Contact Wire are drawn by Roebling in round and grooved shapes to meet every electric railway service.

The properties of both round and grooved sections are in accordance with the requirements of the American Society of Testing Materials, current standard specifications for round and grooved hard drawn copper trolley wire, B47-36 Copper; B9-36 Bronze Contact Wire.

ONLY A FINE PRODUCT MAY BEAR THE NAME ROEBLING

MECHANICAL Loading—of high or low coal—is vastly facilitated with the NEW Enterprise Mine Cars.

New in design—these cars have been performance-tested for construction, stamina and all-round serviceability.

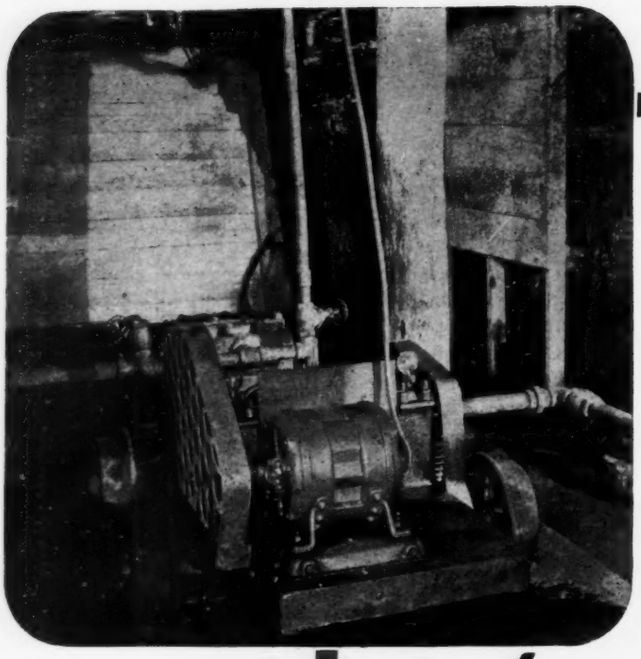
Always a leader in the development of modern mining practices, which lead to lower haulage costs, Enterprise offers—a low-type, maximum-capacity car which costs less per cubic foot of capacity than any other design.

Maximum tonnage at minimum cost—the ultimate in model mine practice—is an achievement which ENTERPRISE will be glad to demonstrate.

ENTERPRISE

WHEEL & CAR CORP.

BRISTOL, VA., TENN. HUNTINGTON, W. VA.



BELL AND ZOLLER MINES RELY ON DEMING PUMPS *to keep them dry!*

POPULAR TYPES OF DEMING PUMPS FOR MINE DEWATERING

★ ★ ★

Deming Deep Well Turbine Pumps. Features: Water lubrication. Cutless rubber bearings. Adjustable impeller clearance. Stainless steel bearing sleeves. Complete range of sizes.

Deming-Mueller Centrifugal Pumps. Single stage. Two Ball Bearing Type. Separate liquid end can be made of special, corrosion-resisting alloys when required. Support head is of standard cast iron construction. Capacities range from 10 to 3600 gallons per minute.

Deming "Oil-Rite" Double-Acting Mine Pumps Fig. 1896. These pumps are engineered for heavy duty, mine gathering service.

Deming Triplex Pumps. A wide range of types, sizes and capacities for all requirements.

● Nine Deming Pumps are still giving dependable performance after many years of dewatering service in the Creston and Ziegler mines of "Bell and Zoller" in Illinois. The Typical pump illustrated was photographed in the famous "Ziegler No. 2" mine.

The record of these pumps gives striking evidence of what YOU can expect from Deming Pumps which assure even greater service today because of constant engineering developments made by Deming in the past few years.

You can look to Deming and Deming Distributors for practical, economical solutions to all mine pumping problems. *Your* interests are our responsibility. *Let's get together!*

THE DEMING CO. • SALEM, OHIO

DEMING MINE PUMPS FOR DEWATERING SERVICE

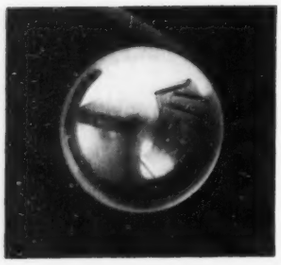
Balance in Production

The balance of Fafnir production between standard and specialized ball bearings results in important advantages. Because so wide a range of types and sizes are standard items in the Fafnir line, engineering and production of specialized bearings can be limited to those where a definite departure from stock material is absolutely necessary.

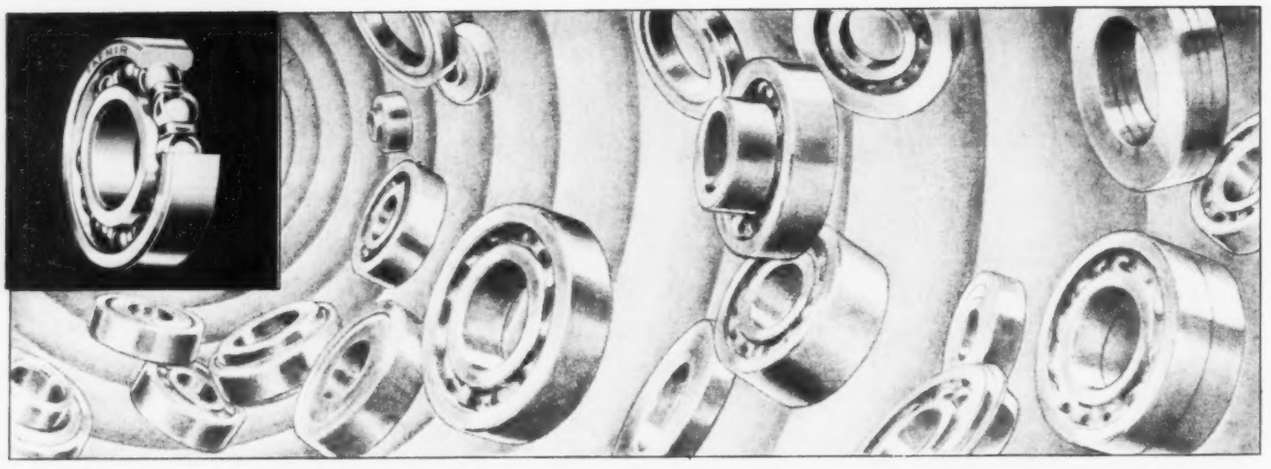
Yet, when required, these specialized bearings are more efficiently produced because of Fafnir's extensive experience with *all* types. That is why Fafnir engineering and production staffs are better able to handle all customers' demands for specialized applications. And that is how Fafnir brings down costs and speeds up service on specialized bearings.

FAFNIR BALL BEARINGS

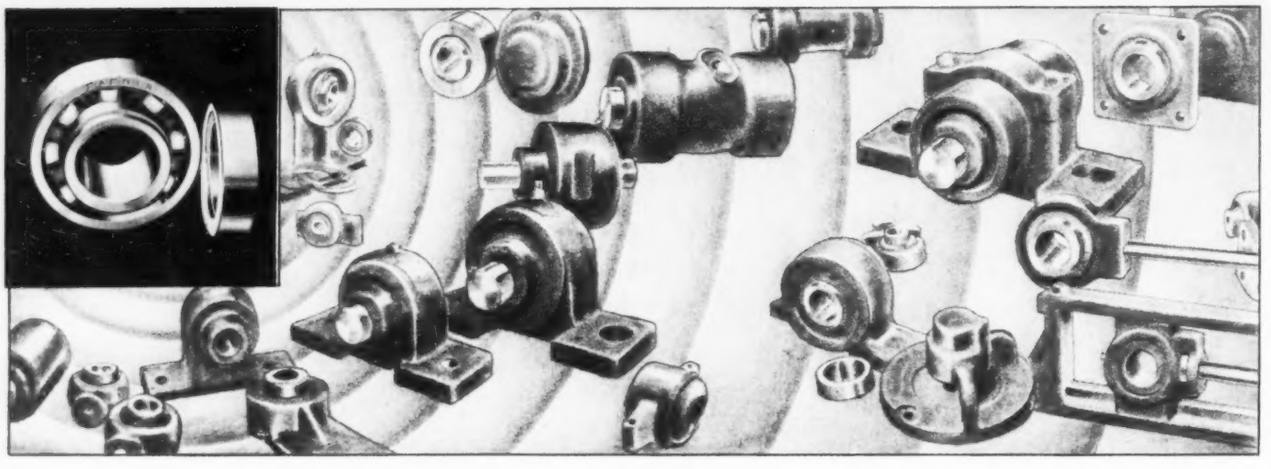
THE BALANCED LINE . . . MOST COMPLETE IN AMERICA



"STANDARD" AND "SPECIALIZED" ARE *Sisters Under the Skin*



The headlong pace of to-day's industrial expansion has resulted time and again in a specialized bearing development from Fafnir today becoming the standard of the industry tomorrow. From its two basic Radial and Wide Inner Ring Bearing types, Fafnir has pioneered hundreds of specialized bearings which, now in regular pro-

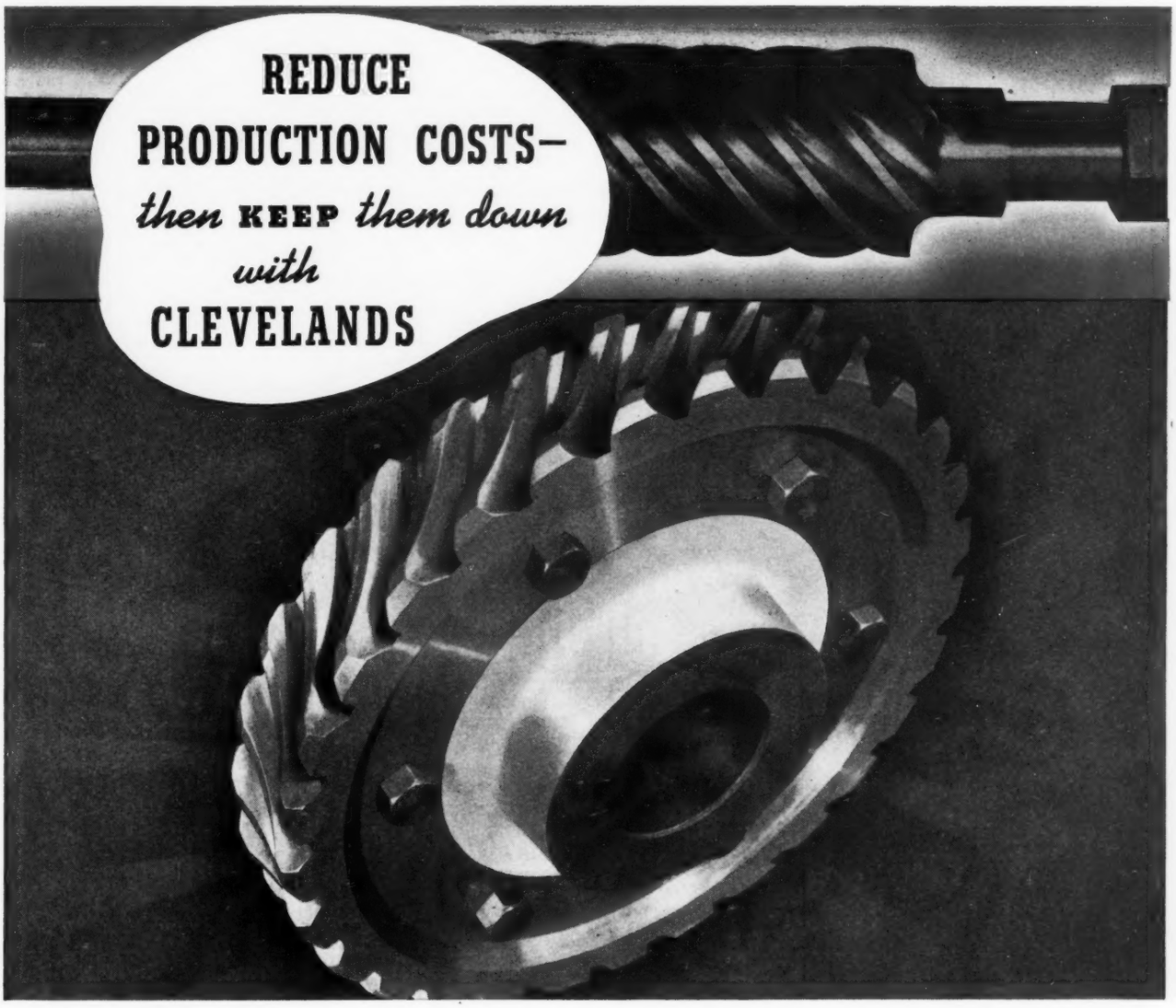


duction, have extended the range of Fafnir types and sizes into the most complete line in America. Every single one of these pioneering jobs has broadened Fafnir's experience—added to Fafnir's ability to pioneer further as industry reaches into newer fields—so that to-day, Fafnir offers to standard bearing users *the most complete line;* and to those whose demands are specialized, *the most complete store of experience*, resulting from building that line. The Fafnir Bearing Company, New Britain, Conn.

Send for
Engineering Manual No. 35

FAFNIR BALL BEARINGS

THE BALANCED LINE . . . MOST COMPLETE IN AMERICA



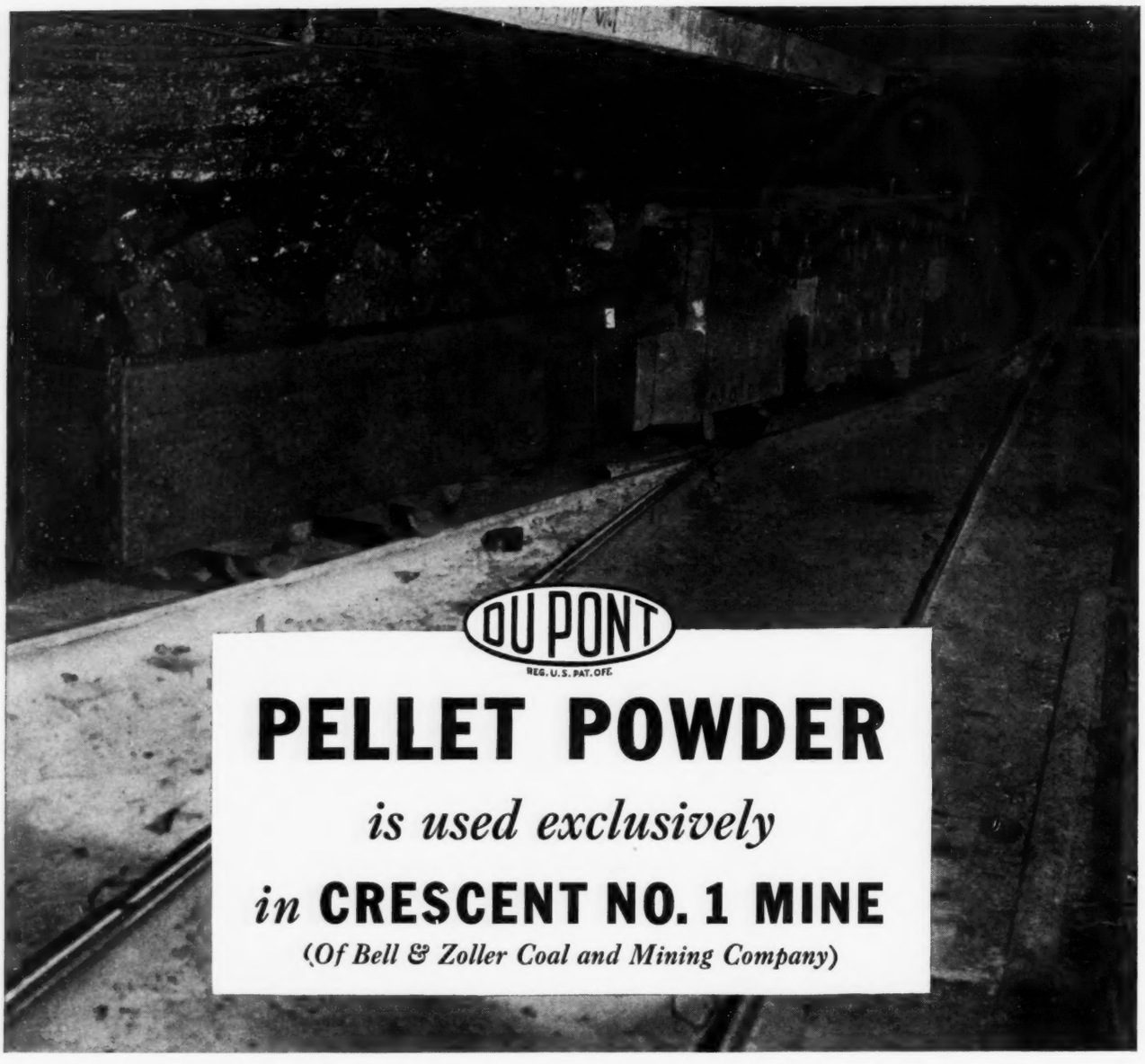
★ New coal-mining and preparation projects designed for low-cost volume production, are properly featured as models and command special interest for a time.

But *owners* must enjoy these benefits *permanently.* The modern machinery that reduces production costs at the outset must *keep* them down, year in and year out. In scores of mining, coke and preparation plants, Cleveland Worm Gear Drives safeguard production demands by delivering abundant power to more than 50 different kinds of equipment, without interruption and at practically no maintenance expense.

Clevelands entered the Coal Industry 15 years ago —their enduring performance under trying conditions has earned the confidence of machine builders and mine operators in every important district. Design Engineers know Clevelands and will gladly install them in your new machinery. A nearby Cleveland District Representative will call upon request. The Cleveland Worm & Gear Company, 3257 E. 80th Street, Cleveland, Ohio.

Affiliate: The Farval Corporation, Cleveland, Manufacturers of Centralized Systems of Lubrication

★ CLEVELAND *Worm Gear Drives*



GOOD "LUMP" is an important consideration at Bell & Zoller's Crescent No. 1 mine. The illustration above shows a typical loaded car in Crescent No. 1—and shows also that they *do* get good lump in spite of hard shooting conditions in a relatively thin seam.

The fact that Crescent No. 1 relies exclusively on Du Pont Pellet Powder to produce good lump under these difficult conditions constitutes a significant indication of confidence in its inherent superiority.

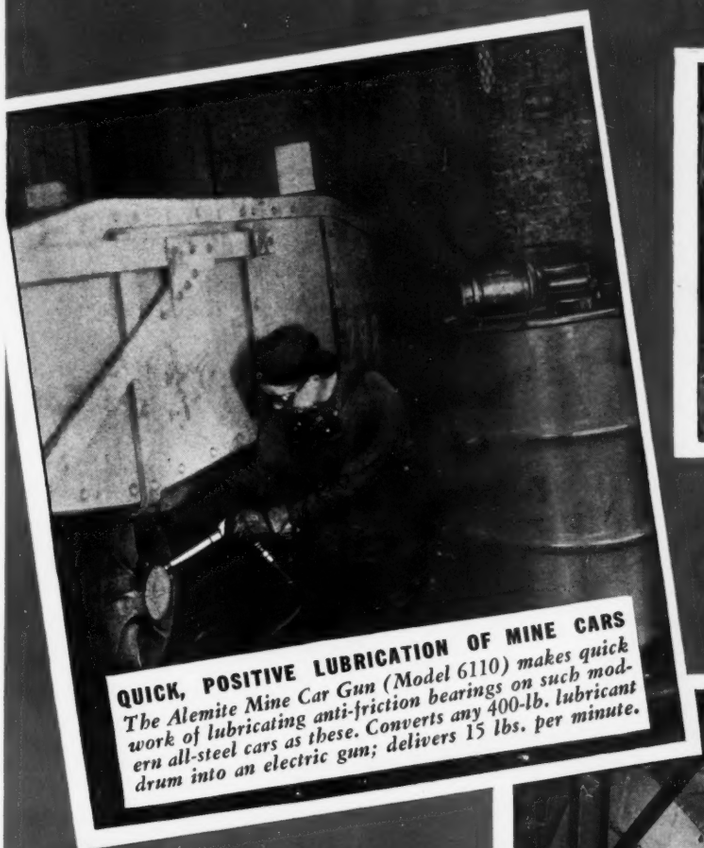
Du Pont Pellet Powder is manufactured in five grades to meet variable conditions; each cartridge containing four pellets, of uniform dimensions, wrapped in moisture-proof paper. Diameter of pellets may be 1¼", 1⅜", 1½", 1¾", 2", or 2½", as desired.

Expert assistance in the selection and application of Du Pont Pellet Powders or permissible explosives is available on request.

E. I. DU PONT DE NEMOURS & CO., INC., EXPLOSIVES DEPARTMENT, WILMINGTON, DEL.

DU PONT EXPLOSIVES *and* BLASTING ACCESSORIES

Alemite Guns and Fittings on Mine Cars, Conveyors, Cleaning Equipment Save Money for Bell & Zoller



QUICK, POSITIVE LUBRICATION OF MINE CARS

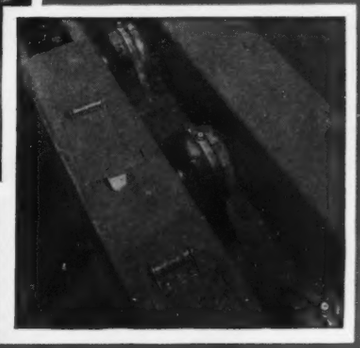
The Alemite Mine Car Gun (Model 6110) makes quick work of lubricating anti-friction bearings on such modern all-steel cars as these. Converts any 400-lb. lubricant drum into an electric gun; delivers 15 lbs. per minute.

SAVES TIME ON ANTI-FRICTION BEARINGS

Hundreds of modern all-steel mine cars in Zeigler Mines Nos. 1 and 2, as well as in mines of Crescent and Centralia Coal Companies, are kept in fine running order by regular lubrication with the Alemite Electric Mine Car Gun.

ALEMITE INSURES CONTINUOUS OPERATION

Bearing failures would be expensive on this big Robins Gyrex Grizzly Screen. That's why every bearing is equipped with an Alemite Fitting (see close-up) to insure positive, dependable lubrication. Hundreds of Timken-equipped idlers on belt conveyors in this plant are also provided with Alemite Fittings and lubricated with Alemite Guns.



THE Bell & Zoller enterprise represents one of the largest installations of Alemite Equipment in the coal industry.

Modern Alemite Lubrication Equipment is saving time, lubricants, and machinery for progressive coal producers everywhere. Write for our important manual, "Alemite Controlled Lubrication."

ALEMITE —*A Div. of Stewart-Warner Corp'n.*
1838 Diversey Parkway, Chicago, Illinois
Stewart-Warner-Alemite Corp'n. of Canada, Ltd.
Belleville, Ontario

ALEMITE

REG. U. S. PAT. OFF.

WORLD'S LARGEST MANUFACTURERS OF LUBRICATION PRODUCTS

Enjoy Horace Heidt and his Alemite Brigadiers every Monday evening, Columbia Coast-to-Coast Network. See local papers for time of broadcast.

You'd turn off

Bell & Zoller use miles of Anaconda cables

Miles of Anaconda trolley wire and feeder cables are furnishing safe and effective transmission of power to the extensive haulage and 100% mechanized mining operations of Bell & Zoller at Zeigler, Ill. This fine example of electrification is proof that modernized wiring pays in the coal industry. Anaconda offers modern, improved wire and cable that mean decidedly lower electrical costs, fewer breakdowns, more efficient machine operation. Let our engineers consult with yours and determine where savings can be made.

Anaconda

General Offices: 25 Broadway, New York

a dripping faucet

—why not stop invisible electrical leaks?

Neglecting electrical circuits costs mine owners thousands in breakdowns . . . high power bills

YOU can *see* a faucet dripping. But an overloaded electric circuit may be wasting money in the form of heat losses without your ever knowing it. Only the treasurer, wondering why bills are so high, suspects that something must be wrong.

Heat losses are but one way in which dollars fly out the window needlessly when electrical circuits are neglected. Frequent breakdowns are another. Men and machines stand around idle. Or, voltage drops reduce machine output. Lumped together, the damages the industrial plant suffers from antiquated, deficient wiring are often enormous. And authorities estimate that *nine out of ten industrial plants today are being penalized because of obsolete electric wiring!*

One of many Anaconda cables that save money in coal mine service

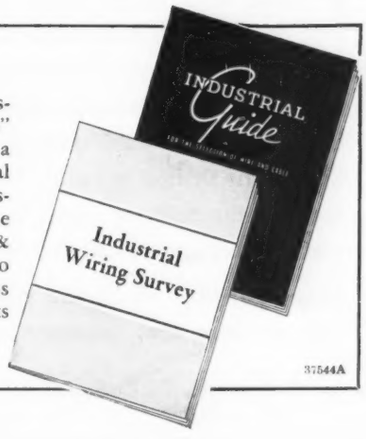
Security-Flex is an exclusive Anaconda design. The 60% all-rubber cord with the slip-proof plastic center and herringbone construction mean ability to "take it" in rough usage. On recommended list of U. S. Bureau of Mines. Write for further information on Security-Flex.

Safeguard your project

A wiring survey will cost you nothing and may save you thousands of dollars. We offer here a complete plan for such a survey. The books shown at right give you everything you need to initiate a check-up of your electric circuits. New, informative, they are being used by hundreds of concerns. Send for them today.

If you have a specific problem in mind, consult our Engineering Department. We will cooperate without obligation. Why not take advantage of the many important improvements in cable design pioneered by Anaconda Wire & Cable Co.? Let us tell you about them.

FREE! The "Industrial Wiring Survey" tells how to make a check-up of electrical circuits. The "Industrial Guide for the Selection of Wire & Cable" tells how to correct conditions found. Both books will be sent free.



37544A

Wire & Cable Company

ANACONDA

Chicago Office: 20 North Wacker Drive • *Sales Offices in Principal Cities*

WATER RECOVERY AT DRIFTON COLLIERY WITH A DORR SYSTEM

COXE BROTHERS AND COMPANY, INC. have installed this modern 85′ diameter Dorr Torq Thickener to clarify coal laden breaker wash water at their Drifton, Pennsylvania colliery. Handling a flow of 1500 to 2000 gallons per minute, the Dorr System at Drifton gives a clear water overflow for reuse in the colliery. Thus the possibility of a wash water shortage has been definitely eliminated.

Other benefits which are also being realized with Dorr Systems are: savings in water pumping costs —prevention of stream pollution—recovery of fines ready for draining and drying.

The best solution to your own problem may be found in the experience records of Dorr engineers. These have been gathered from over eighty Dorr installations at both anthracite breakers and bituminous washers.

•

If acid mine water is also a problem at your colliery, the treatment which has been worked out by our laboratory staff may very likely be successfully applied.

DORRCO

WHY NOT CALL A DORR ENGINEER INTO CONSULTATION TODAY?

THE DORR COMPANY INC.

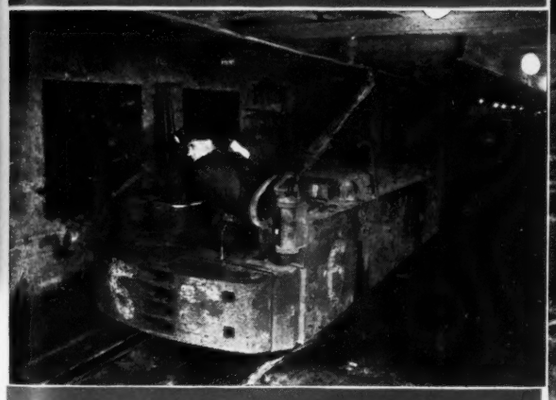
ENGINEERS • 570 Lexington Ave., New York

ATLANTA • TORONTO • CHICAGO • DENVER • LOS ANGE

DORR TECHNICAL SERVICES AND EQUIPMENT ARE ALSO AVAILABLE FROM THE FOLLOWING COMPANIES:

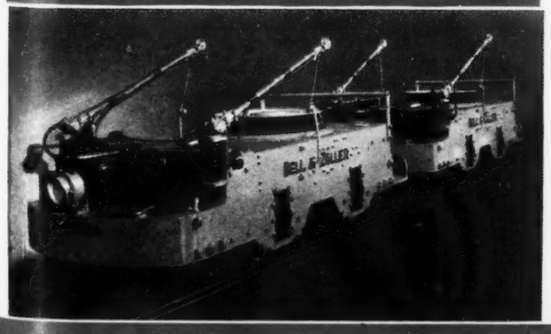
NETHERLANDS: Dorr-Oliver N.V. The Hague • ENGLAND: Dorr-Oliver Company Ltd., London • GERMANY: Dorr Gesellschaft, m.b.H. Berlin • FRANCE: Soc. Dorr-Oliver
ITALY: S.A.I. Dorr-Oliver, Milan • JAPAN: Sanki Eng. Co., Ltd., Tokyo • SCANDINAVIA: A.B. Hedemora, Hedemora, Sweden • AUSTRALIA: Crossle & Duff Pty. Ltd., Melb
ARGENTINA: Luis Fiore, Buenos Aires • SOUTH AFRICA: Edward L. Bateman Pty. Ltd., Johannesburg • BRAZIL: Oscar Taves & Co., Rio de Ja

The view above shows a Goodman 13-ton trolley locomotive on the main haulage-way, hauling a trip of loaded cars at the Zeigler, Illinois, mines of Bell & Zoller. The view below shows a 15-ton locomotive which has just hauled a trip of cars more than two miles to the shaft. This is one of a fleet of 15-ton Goodman locomotives in operation at this mine.



—and the latest addition to the Bell & Zoller fleet

These two 8-ton Goodman locomotives for gathering work were recently added to the Goodman fleet at Zeigler.



. . . at Bell & Zoller with Goodman Locomotives

MOVING 13,000 tons of coal daily from the face to the mine shaft at the Zeigler mines of Bell & Zoller is a task that would test the efficiency of any mine haulage system.

Goodman locomotives play an important part in keeping this tonnage rolling along smoothly and efficiently. Not only at Zeigler, but also at Peoria and Centralia, Illinois, these dependable locomotives have established the same fine performance records that have won recognition in mines all over the world . . . performance records that are based on low maintenance and operating costs as well as tonnage handled.

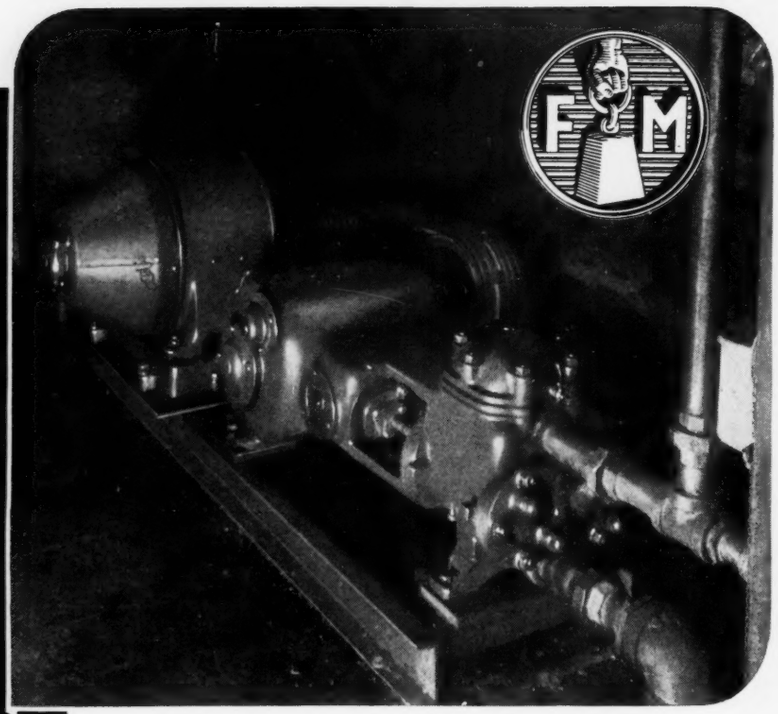
When analyzing the possibilities of reducing your production costs, it will pay you to check into every detail of your haulage problem. The Goodman organization will be pleased to co-operate with you in any study you may wish to make. Three new bulletins are now on the press covering Goodman Gathering, Haulage, and Storage Battery Locomotives, and we suggest that as a first step in your check-up you write for these new bulletins. Goodman Manufacturing Company, Halsted Street at 48th, Chicago, Illinois.

GOODMAN

LOCOMOTIVES • COAL CUTTERS • LOADERS • CONVEYORS

WILKES-BARRE · PITTSBURGH · HUNTINGTON · BIRMINGHAM · ST. LOUIS · DENVER · SALT LAKE CITY

Scientific Management Makes Model Mines... and Buys F-M Pumps



● The choice of Bell & Zoller properties as "The Model Mines of 1937" is proof of their progressive and scientific management. This same habit of considering every factor and marking every result led also to the use of Fairbanks-Morse pumps by Bell & Zoller. Experience has proved to them that F-M pumps perform as well in a mine as they do on paper.

The 50 g.p.m. F-M Duplex Piston Pump illustrated is a recent addition to the drainage equipment of the Centralia mine. There are many other F-M pumps of piston and centrifugal types in this and the other Bell & Zoller properties.

Bring your pumping problems to F-M also. The line includes a pump meeting every mining condition generously. Bulletin 6155-16 will give preliminary data. Write for it. Fairbanks, Morse & Co., 900 S. Wabash Ave., Chicago, Ill. 34 branches at your service throughout the United States.

FAIRBANKS SCALES USED

Accurate weighing is a fundamental of profitable management. Bell & Zoller assure this by using Fairbanks Scales, which maintain their profit-guarding accuracy through many years of the service to which railroad scales, for example, are subject. The Fairbanks railroad scale shown is of the type used at several Bell & Zoller properties.

Other types of Fairbanks scales complete the coverage of all weighing needs at any mine. Write for Bulletin ASB401-16.

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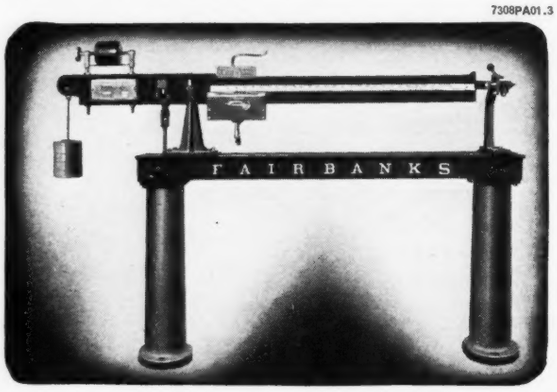
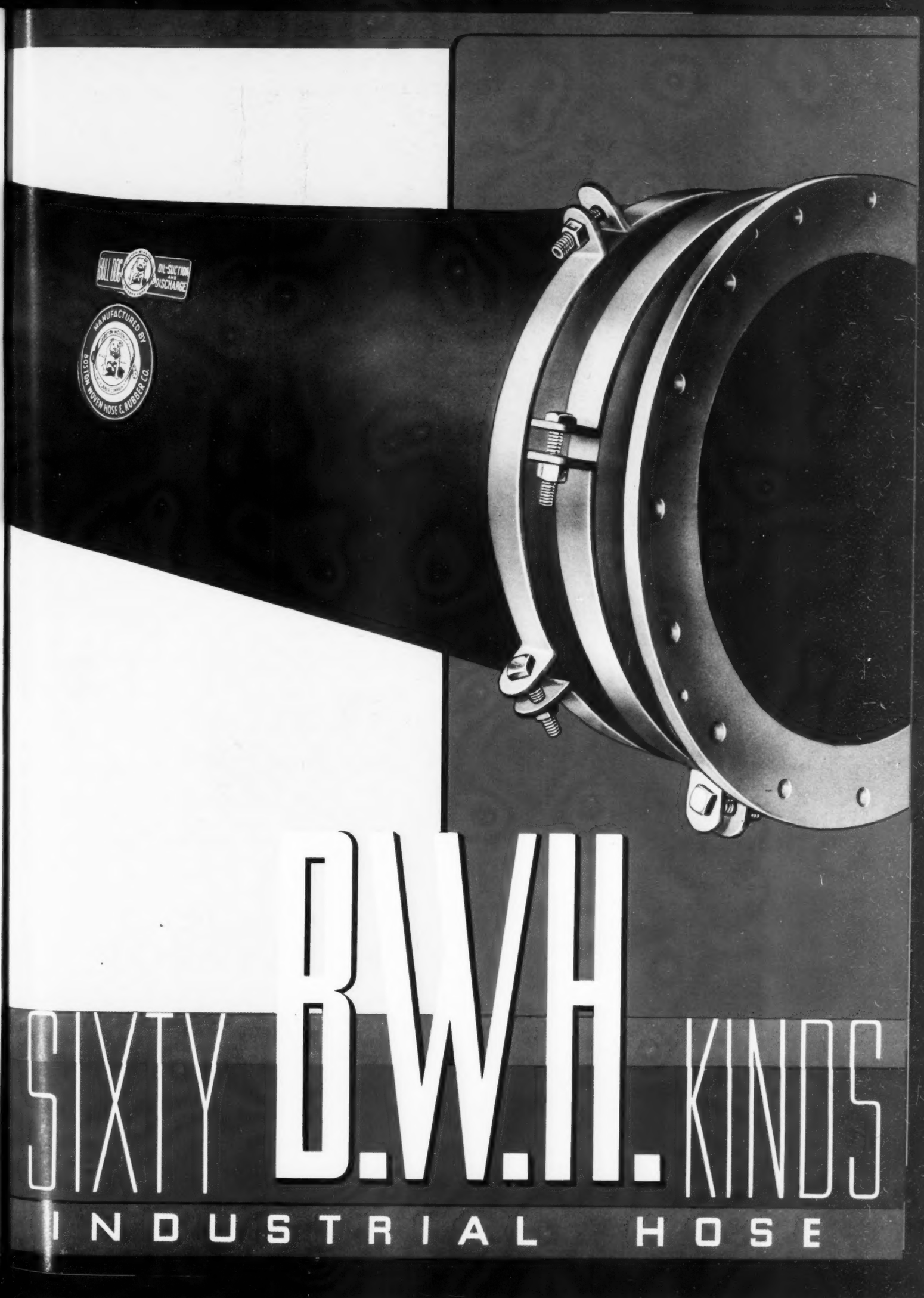


FAIRBANKS MORSE

DIESEL ENGINES
PUMPS
ELECTRICAL MACHINERY
FAIRBANKS SCALES
RAILROAD EQUIPMENT
WATER SYSTEMS
REFRIGERATORS
RADIOS
WASHERS
FARM EQUIPMENT
STOKERS
AIR CONDITIONERS

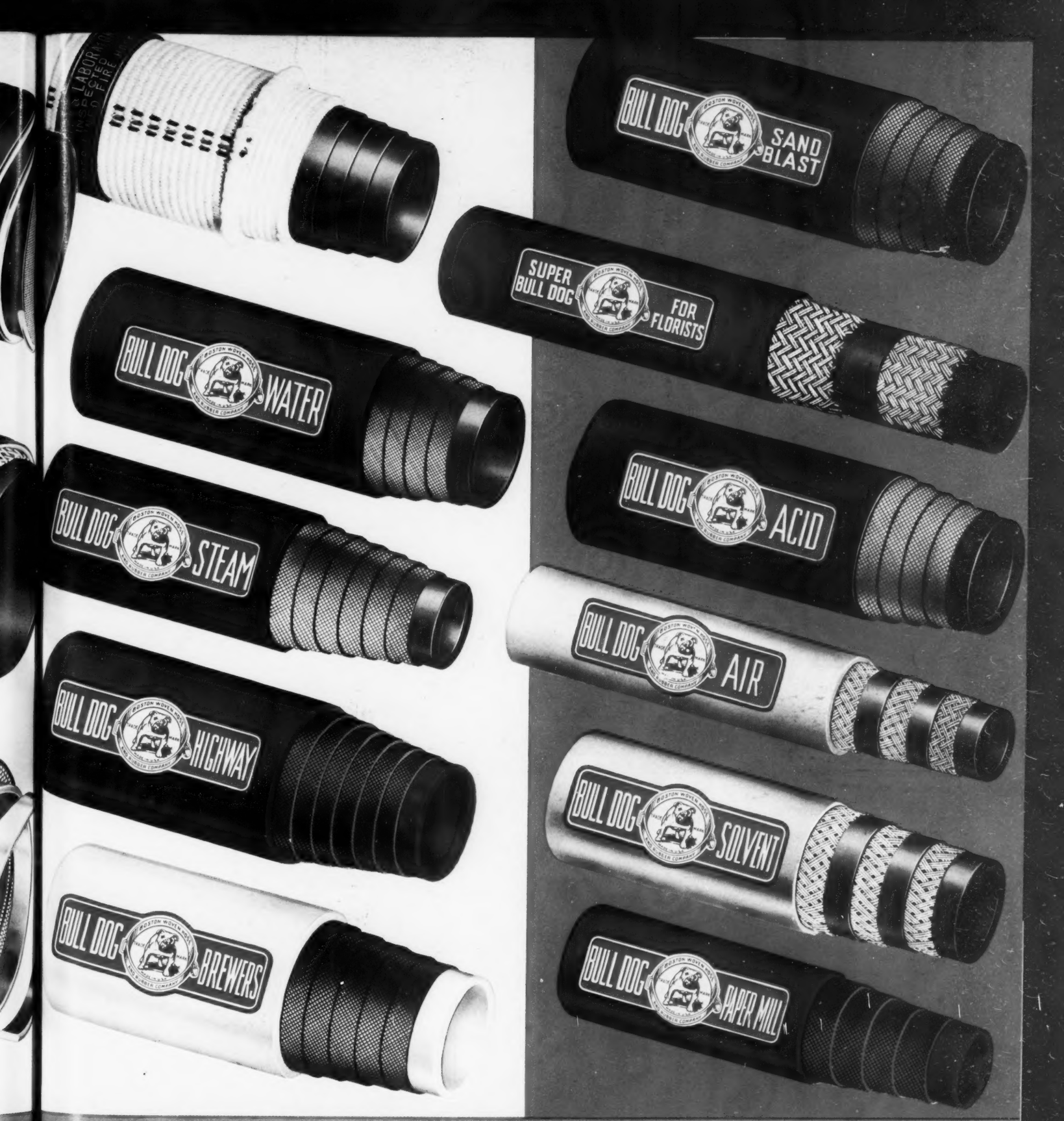
Pumps


BULL DOG
OIL-SUCTION AND DISCHARGE
MANUFACTURED BY
BOSTON WOVEN HOSE & RUBBER CO.
SIXTY B.W.H. KINDS
INDUSTRIAL HOSE

THE BWH LINE OF HOSE

for EVERY

BOSTON WOVEN HOSE



E INCLUDES A TYPE

SERVICE

E AND RUBBER COMPANY

HOSE IS OUR MIDDLE NAME

BOSTON WOVEN HOSE AND RUBBER CO.

WORKS: CAMBRIDGE, MASS. P.O. ADDRESS: BOX 1071, BOSTON, MASS.

IN THE BELL *and* ZOLLER OPERATIONS
Every man underground wears
an EDISON ELECTRIC CAP LAMP

THE strict enforcement of safety in all operations of the Bell and Zoller Coal Mining Company naturally includes the most modern safety equipment and practice.

In the 100% mechanized Zeigler Mines 1 and 2, Edison Electric Cap Lamps are *standard equipment.* Each worker below ground wears this dependable lamp (usually on an M.S.A. Skullgard!). Protected from the hazards of insufficient illumination, he is able to work better and faster by the effective light the Edison Lamp unfailingly provides.

If *your* miners are not equipped with these cost-cutting, hazard-reducing Edison Electric Cap Lamps—we'd like to give you a demonstration! And tell you the details of the easy rental plan by which you may purchase Edison Electric Cap Lamps without a penny of capital outlay. A card or letter will bring prompt response.

MINE SAFETY APPLIANCES CO.

Braddock, Thomas & Meade Sts., Pittsburgh, Pa.

District Representatives in Principal Cities

M. S. A. Products include Breathing Apparatus . . . Inhalators . . . Comfo Respirators . . . Masks of all Types . . . Gas Indicators . . . Gas Detectors . . . Safety Goggles . . . Protective Hats and Caps . . . Edison Electric Cap Lamps . . . Safety Clothing . . . First Aid Equipment.

Descriptive Bulletins will be sent on request.

The NEW WORD for is Westinghouse

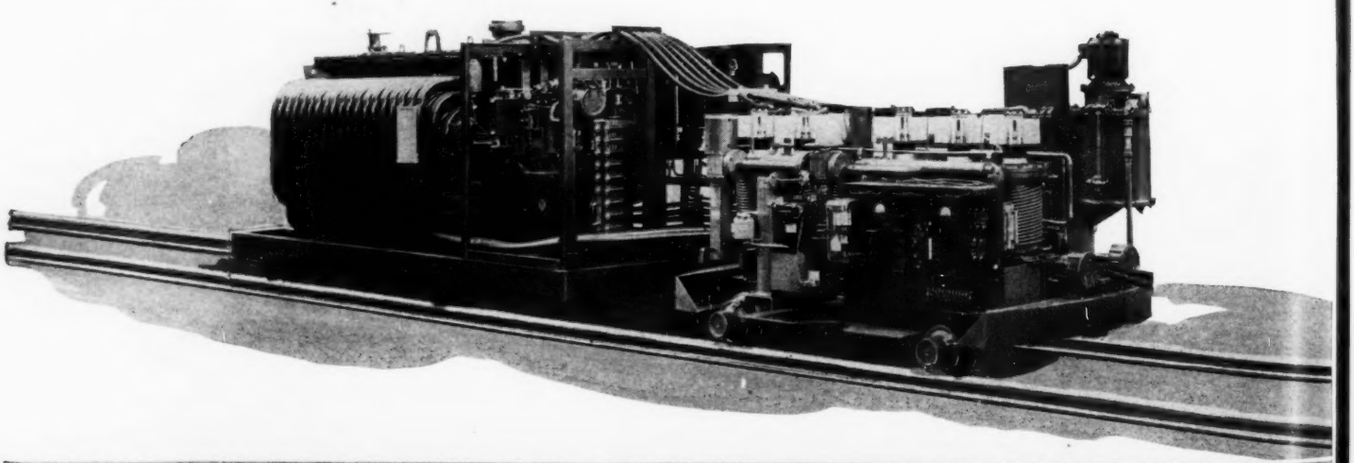
● Power conversion at greatly increased efficiency under the varying load conditions encountered in coal mining operations is obtained with Westinghouse Ignitron Rectifiers. At 25 per cent load, for example, a typical Westinghouse Ignitron Rectifier installation is giving over 91 per cent efficiency, an increase of from 10 to 20 per cent compared with rotating machinery.

Such high efficiency is maintained over the entire load range. Westinghouse Ignitron Rectifiers are especially well adapted to coal mining requirements because of:

1. High efficiency over complete load range.
2. High short time overload capacity.
3. No heavy foundations required.
4. No heavy bearings to lubricate or maintain.
5. Low starting current demands.
6. Simplicity of automatic control.

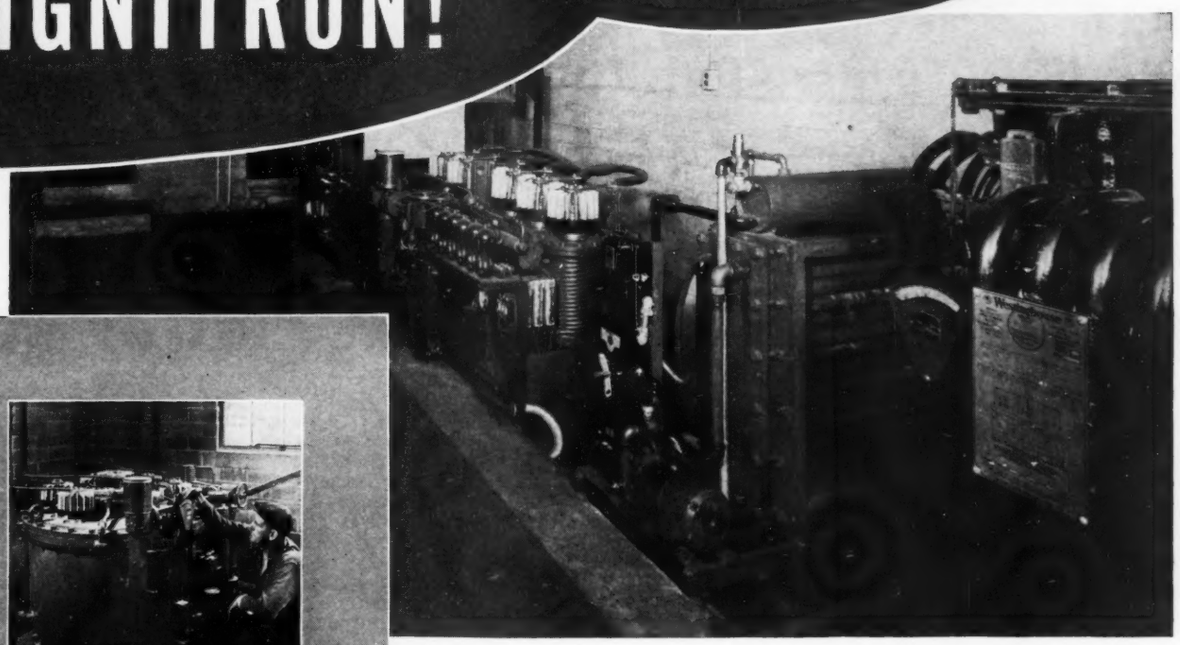
It will pay you to investigate the savings you can make with Westinghouse Rectifiers for new or additional conversion capacity requiring either 275 or 600 volts D.C. without delay. Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pennsylvania. Representatives in all principal mining centers.

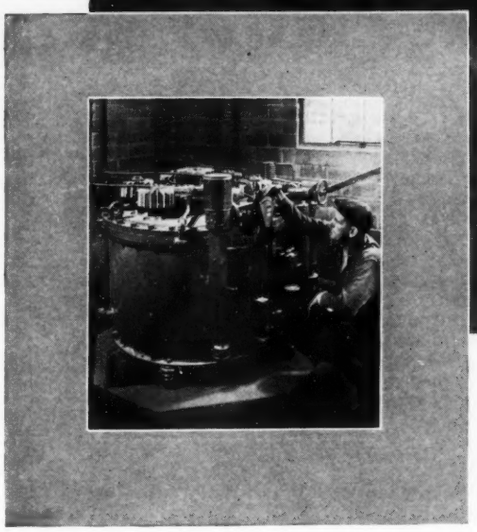
J 10055



Westinghouse

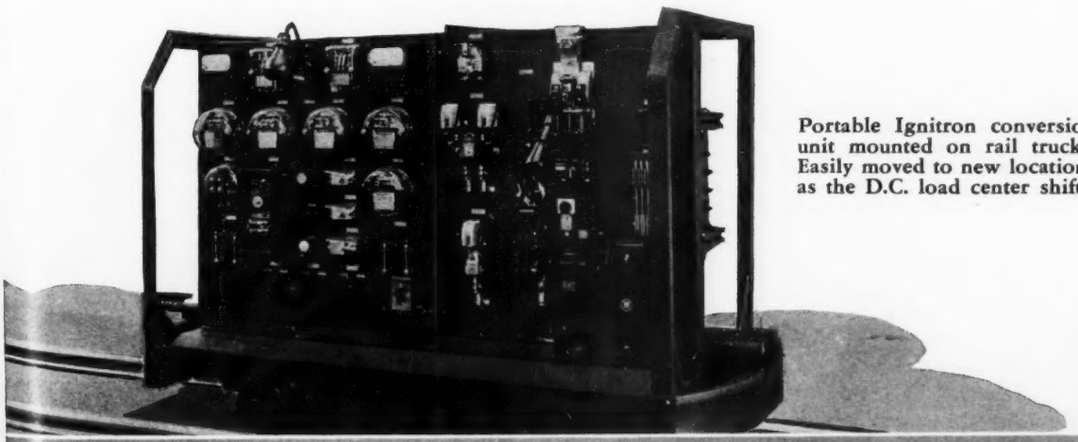
Low cost Mine Power Conversion
IGNITRON!





Above, underground substation consisting of Westinghouse Ignitron Rectifier, transformer and control apparatus.

Left, Westinghouse also makes a complete line of steel tank Mercury Arc Rectifiers. Write for Booklet 2096.



Portable Ignitron conversion unit mounted on rail trucks. Easily moved to new locations as the D.C. load center shifts.

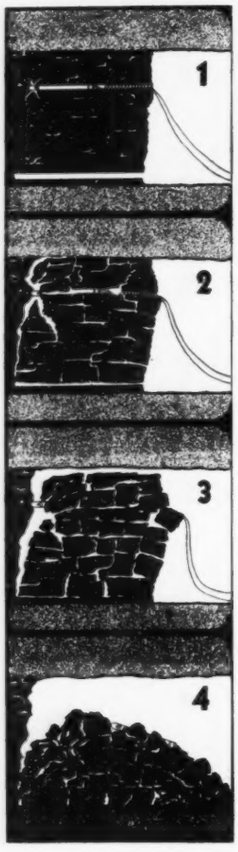
W
WESTINGHOUSE ELECTRIC

Ignitron RECTIFIERS

It is significant that **BELL & ZOLLER** *and other*

Outstanding use

in all important coal fields



HOW COAL IS DISLODGED *with*

CARDOX
The Non-Explosive Mining Method

The illustrations at the left show how CARDOX heaves coal forward with a force that "shoves" without shattering.

A CARDOX cartridge (1) consists of a steel shell filled with liquid carbon dioxide.

When current is applied to the heating element in the cartridge, the liquid CO^2 is vaporized into gas. When sufficient pressure is created the carbon dioxide ruptures a soft steel disc at the inner end of the cartridge. The released gas permeates the natural seams and fissures of the coal (2) heaving it forward (3) in firm blocky lumps (4) without weakening the natural structure of the coal.

Thus with CARDOX mined coal you are assured of loading efficiency, maximum of coarse sizes, firmer structure, and a minimum of degradation.

PARTIAL LIST OF USERS IN

WEST VIRGINIA	Number of Mines Served
BELLWOOD COAL COMPANY	1
BRULE SMOKELESS COAL CORPORATION	1
CRAB ORCHARD IMPROVEMENT COMPANY	2
DETROIT MINING COMPANY	1
IMPERIAL NEW RIVER COAL COMPANY	1
IMPERIAL SMOKLESS COAL COMPANY	1
KELLEY'S CREEK COLLIERY COMPANY	3
KOPPER'S COAL & TRANSPORTATION CO.	2
MINGO MINING COMPANY	1
PEMBERTON COAL AND COKE COMPANY	1
RAINE LUMBER AND COAL COMPANY	1
RAYMOND CITY COAL & TRANSPORTATION COMPANY	1
RALEIGH WYOMING MINING COMPANY	1
SCOTIA COAL AND COKE COMPANY	1
SLAB FORK COAL COMPANY	1
SOUTH SIDE COMPANY	1
WINDING GULF COLLIERIES	1
WOOD COAL COMPANY	1

MONTANA	Number of Mines Served
JEFFERIES COAL COMPANY	1

COLORADO	Number of Mines Served
CONSOLIDATED COAL & COKE COMPANY	1
COLORADO FUEL AND IRON COMPANY	2
MOFFAT COAL COMPANY	1
LOUISVILLE-LAFAYETTE COAL CO.	1
BOULDER VALLEY COAL COMPANY	1
McNEIL COAL CORPORATION	1
WM. E. RUSSELL COAL COMPANY	1
TEMPLE FUEL COMPANY	2

Delivering charged CARDOX cartridges at a Bell & Zoller mine.

Inserting CARDOX cartridge in a drill hole. A safe and easy operation.

Producers CARDOX

'The Non-Explosive Mining Method'

INDICATES WIDE RANGE OF ACCEPTANCE . . . .

KENTUCKY	Number of Mines Served
AJAX COAL COMPANY	1
CREECH COAL COMPANY	2
GOOSE CREEK MINING COMPANY	1
HARVEY COAL CORPORATION	1
KNOTT COAL CORPORATION	1
CARBON GLOW MINING COMPANY	1

ILLINOIS	Number of Mines Served
BELL & ZOLLER COAL & MINING COMPANY	2
FRANKLIN COUNTY COAL CORPORATION	2
OLD BEN COAL CORPORATION	4
CONSOLIDATED COAL COMPANY OF ST. LOUIS	1
PERRY COAL COMPANY	1
GILLESPIE COAL COMPANY	1
REX COAL COMPANY	1

PENNSYLVANIA	Number of Mines Served
BUTLER CONSOLIDATED COAL COMPANY	1
PITTSBURGH COAL COMPANY	3

UTAH	Number of Mines Served
INDEPENDENT COAL AND COKE COMPANY	1
LIBERTY FUEL COMPANY	1
NATIONAL COAL COMPANY	1
PEERLESS SALES COMPANY	1
ROYAL COAL COMPANY	1
SPRING CANYON COAL COMPANY	1
GEO. A. SCHULTZ	1
STANDARD COAL COMPANY	1
UTAH FUEL COMPANY	2

VIRGINIA	Number of Mines Served
PAGE POCAHONTAS COAL CORPORATION	1
OAKWOOD SMOKELESS COAL COMPANY	1
JEWELL RIDGE COAL CORPORATION	1

OKLAHOMA	Number of Mines Served
BUCK CREEK MINING COMPANY	1
A. D. CLARK COAL COMPANY	1
PREMIUM SMOKELESS COAL COMPANY	1
POCAHONTAS PRODUCERS COAL COMPANY	1

ARKANSAS	Number of Mines Served
GREAT WESTERN COAL COMPANY	1
R. A. YOUNG & SON	1

CANADA	Number of Mines Served
ATLAS COAL COMPANY	1

ADDITIONAL NAMES SUPPLIED UPON REQUEST

Inquiries Are Solicited

SAFETY MINING COMPANY

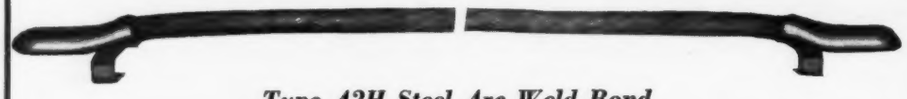
307 NORTH MICHIGAN AVENUE CHICAGO, ILLINOIS

Photo taken 3 minutes after dislodging coal with CARDOX. Note visibility. No smoke . . . No fumes . . . Very little dust.

CARDOX rolls out coal—permitting full benefits of mechanized loading.

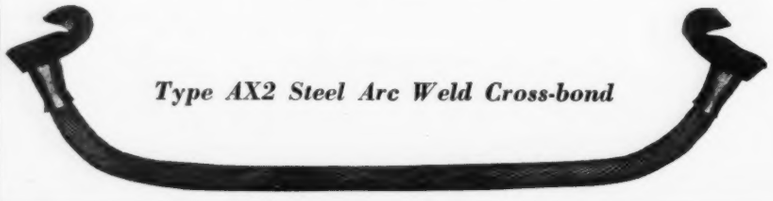
B & Z *chooses* E.R.I. Co. RAIL BONDS

In the Bell & Zoller Mines, nearly 100 trolley pole locomotives, hauling heavy daily tonnage, demand that track return circuits be effectively and properly bonded. To accomplish this, conditions at their No's. 1 and 2 Mines required a careful analysis. The four types of Rail Bonds illustrated are being used, furnished by the maker whose sole business is to design and supply the proper Rail Bonds for the job.



Type A2H Steel Arc Weld Bond

Type CAEH Copper Arc Weld Bond



Type AX2 Steel Arc Weld Cross-bond

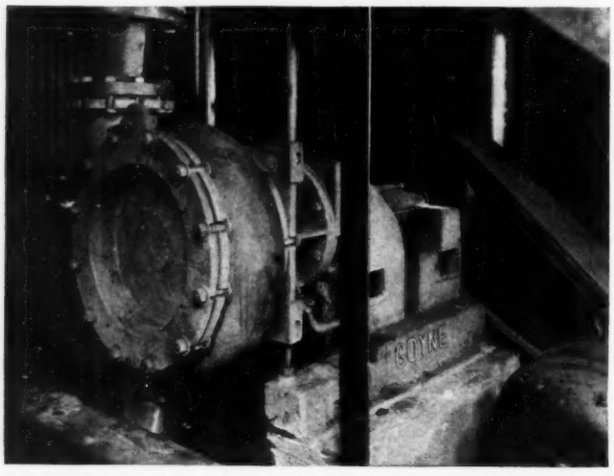
Type CUF Copper Arc Weld Bond

The
ELECTRIC RAILWAY IMPROVEMENT CO.
Cleveland, Ohio

This GOYNE PUMP can be inspected or Repaired in One Half Hour

THE illustration shows one of two Goyne Sand Pumps in a Modern Coal Cleaning Plant. These pumps were selected by the coal company after investigating results obtained from other Goyne installations.

Note the horizontal suction line at the extreme left, and the vertical discharge line. Neither of these lines interferes with the removal of the back cap of the pump, which exposes for inspection or replacement, the impeller, shaft sleeve and wearing plate. How would this compare with your present pump for labor costs chargeable to inspection and replacement of parts?

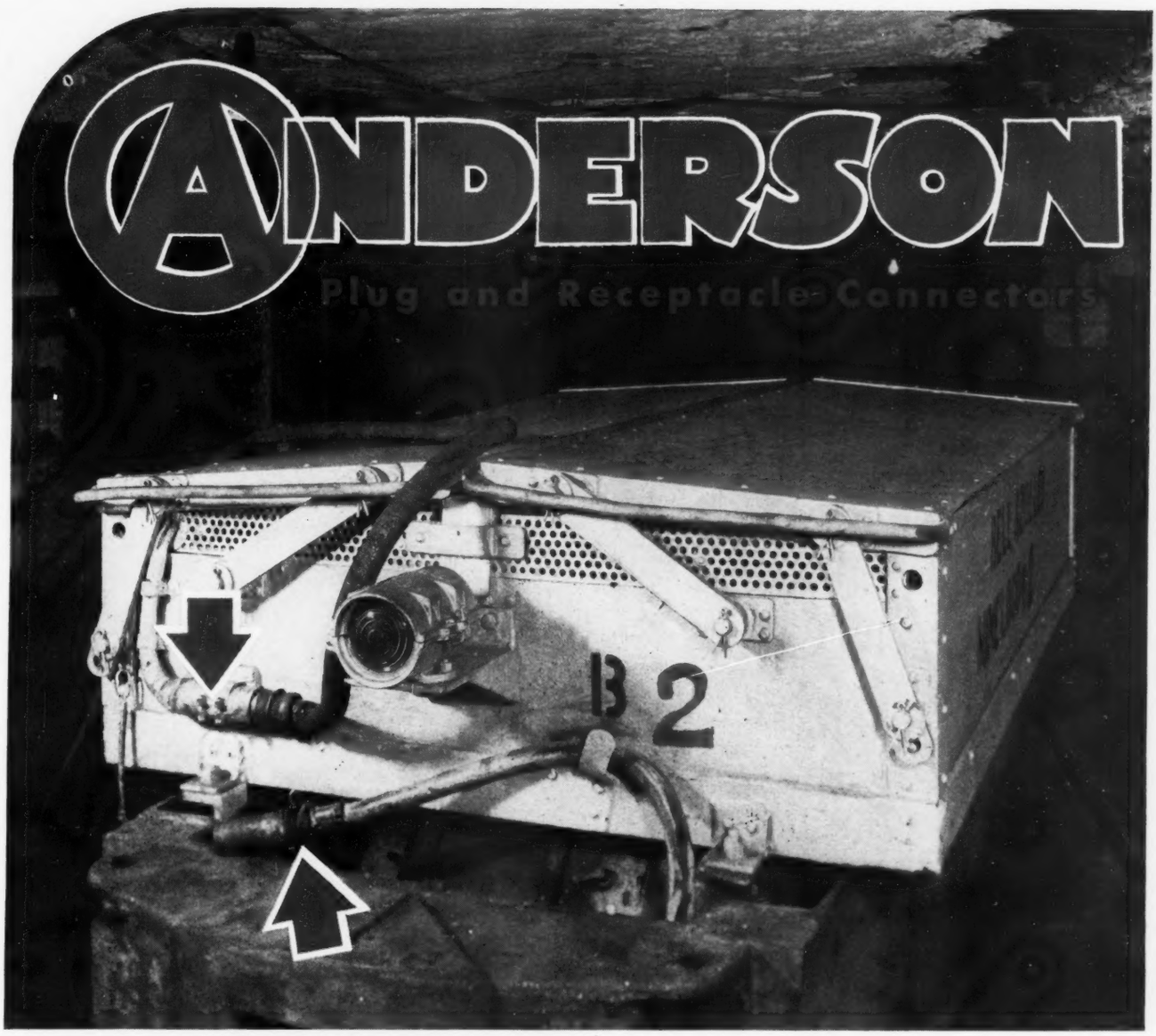


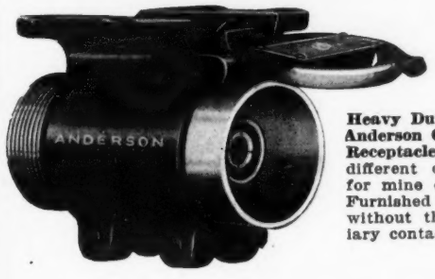
The packing box of this pump is subjected only to suction pressure, thereby reducing to a minimum the tendency of the packing to become impregnated with grit and sand. Packing and shaft sleeve life is greatly increased. Check the cost of packing and shaft sleeve replacements in your present pump.

The elimination of continuous by-passing of the mixture being pumped means maintained capacity and efficiency and also increases the useful life of pump parts. Our design incorporates a simple adjusting feature, by means of which clearance wear may be eliminated while the pump is running. Is your present pump adapted to practical adjustment while in service?

Write us for complete information on this modern pump for Coal Cleaning and Sludge Disposal Service.

GOYNE STEAM PUMP CO.
ASHLAND, PENNA.





Heavy Duty Type N Anderson Charging Receptacle. Made in different capacities for mine equipment. Furnished with or without third auxiliary contact.

Heavy Duty Anderson Charging Plug. Made in various capacities for mine equipment.

Assure Safe Operation at "ZEIGLER"

In their 100% mechanized "No. 1" mine at Zeigler, Ill., Bell & Zoller use six Mancha storage battery locomotives to serve modern high-speed loading machines. Safe charging of the storage batteries in all of these locomotives is assured by the use of *Anderson Plug and Receptacle Connectors.*

Long, safe service is built into all Anderson Plugs and Receptacles—one type having been approved by the U. S. Bureau of Mines for use with "Permissible" mining equipment.

Other Anderson Mine Products include: *Air Flow Relays for mine ventilation control—Heavy Knife Switches—Circuit Breakers—Insulators—Automatic Time Switches—Overhead Line Material—Cable Connectors.*

Write for bulletins.

Albert & J. M. Anderson Mfg. Co.
289-305 A St. Boston, Mass.
New York Chicago Philadelphia London

WOOD PRESERVATION

Statistics show us that approximately 75% of all fatal accidents in our coal mines have been caused directly or indirectly by defective ties or timbers. These accidents can be greatly reduced if sound ties and timbers are procured and properly treated with the most suitable preservatives.

The use of treated materials is economical, too, as it will not be necessary to replace them so frequently.

Bell & Zoller Coal Company is taking advantage of these economies and safety measures by using preservatively treated ties both for underground and surface use. During the past three years T. J. Moss Tie Company has treated more than 2,000,000 feet board measure of various sized ties for them, the underground ties with Zinc Chloride and the surface ties with Creosote Coal Tar Solution.

Progressive mining companies will be interested in the big savings resulting from the use of MOSS treated ties and timbers. If you are not already using them we'll be glad to furnish interesting facts and figures.

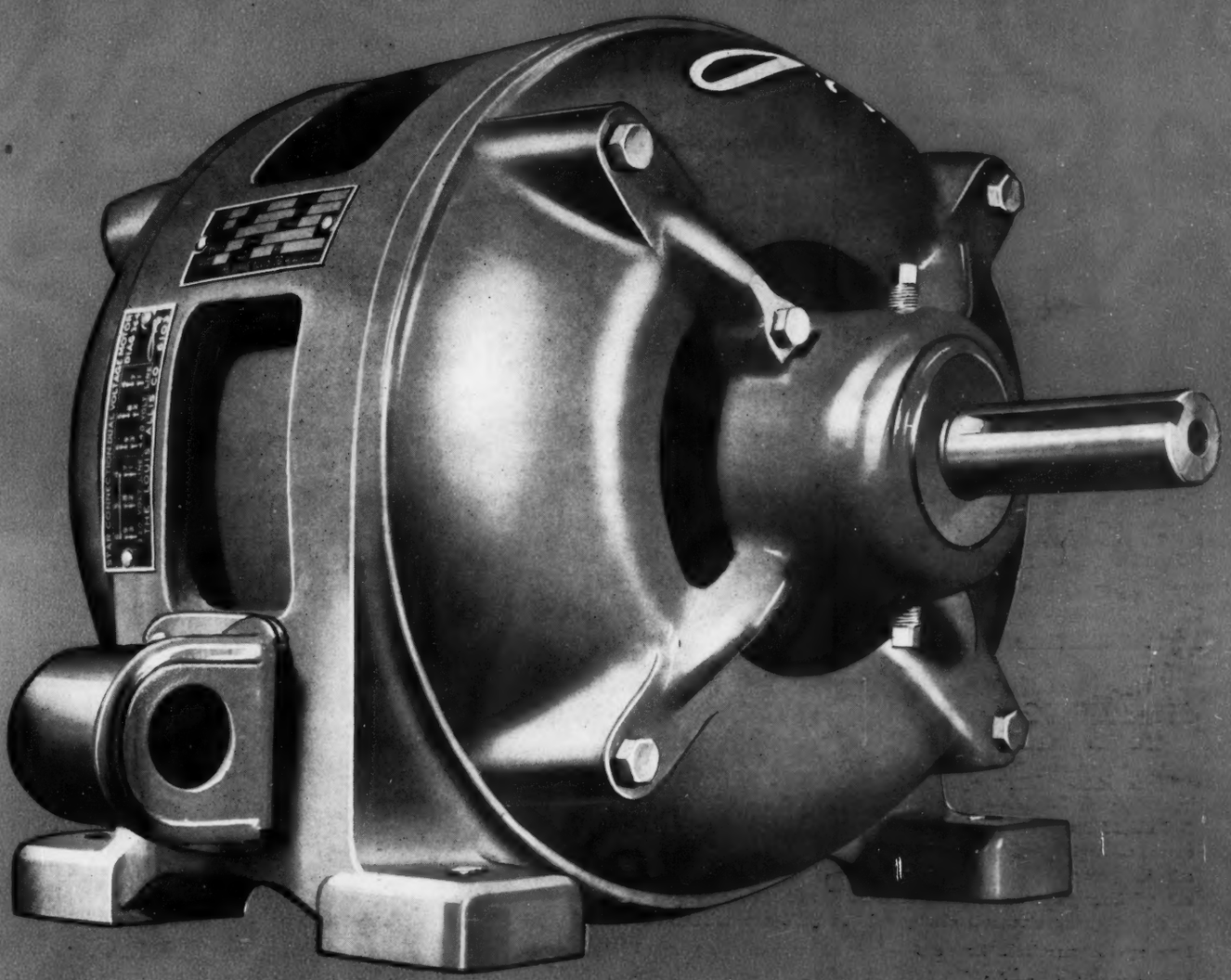
T. J. MOSS TIE COMPANY

ST. LOUIS MTC MISSOURI

The Stamp of Character

Machine Designers Prefer De Laval Worm Reduction Gears
-because they are compact, efficient and so thoroughly well designed and made that they run continuously with only renewal of the lubricating oil at long intervals.
Link-Belt side hill slate dump at Mine No. 253 in the Pocahontas-New River Div. of the Consolidation Coal Co., driven by a 10 hp. motor through a De Laval 29½ ratio Worm Reduction Gear.
De Laval Steam Turbine Co.,
Trenton, N. J.

LOUIS ALLIS



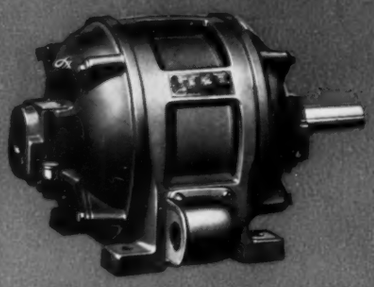
A Size and Type Electric Motor
for Every Industrial Requirement

THE LOUIS ALLIS CO., MILWAUKEE, WIS.

SEE OTHER SIDE

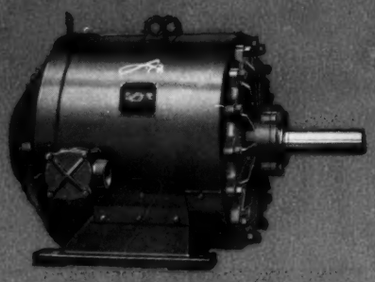
There is a Louis Allis Motor for every job

. . . designed and built from the ground up, as sturdy, powerful motors for successful performance for modern high speed production.



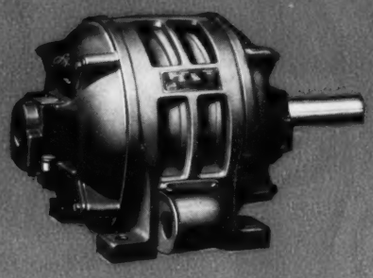
STANDARD OPEN SQUIRREL CAGE MOTOR

Well designed, carefully engineered, precision built—available in a very wide range of both electrical and mechanical modifications. Write for copy of completely illustrated bulletin No. 505 for full details.



EXPLOSION-PROOF MOTOR

For use where gasoline and other petroleum products, lacquer solvents, and equally hazardous liquids are made, used or handled. Approved by Underwriters'. Bulletin No. 508 fully describing will be sent upon request.



RAPID REVERSING MOTOR

If you have a product or operation that requires rapid reversing action (up to 100 times per minute) we will gladly send complete information of construction and advantages of this unusual type motor.

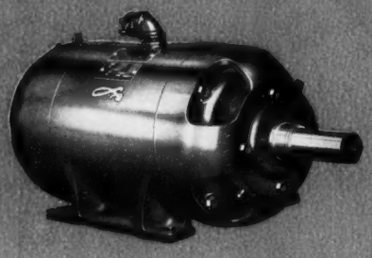
SPLASH-PROOF MOTOR

Designed and built from the ground up as a real splash-proof motor—full protection against acid spills—splashing liquids —high humidity. Write for copy bulletin No. 512 fully describing.

stator housing only illustrated

SELF-CLEANING MOTOR

Designed for use in atmospheres containing non-combustible dust, lint or mild acid fumes. Bulletin No. 511 fully describing this unusual motor will be sent upon request.

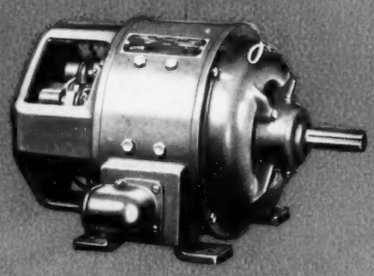


ARBOR MOTORS

These motors are especially adaptable for applications where the available space for mounting is limited. They are available in a wide range of sizes and electrical characteristics. Complete information and suggestions for your particular problem will be gladly sent upon your request.

TOTALLY-ENCLOSED FAN-COOLED MOTOR

For combustible dust and all locations where abrasive, metallic or corrosive dust is present—the tougher the conditions the better this motor likes it. Described fully in bulletin No. 510—write for copy.



STANDARD DIRECT-CURRENT MOTOR

Available in a wide variety of both electrical and mechanical modifications—the proper motor for every job. For complete details write for bulletin No. 507.

GEAR REDUCER MOTORS

Louis Allis motors can be supplied with a very wide range of various types of gear reducers — integral — all-motor — gear-head—vertical—right angle or parallel—the proper drive for every industrial application.
Complete information and suggestions for your particular drive will be gladly sent upon your request.

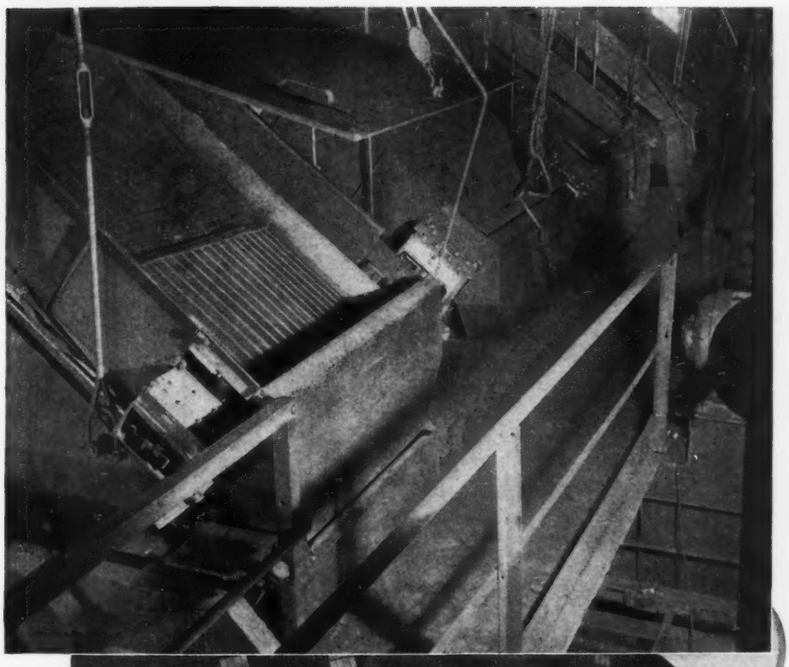
We invite your inquiry . . . your needs will receive our most prompt and careful attention in every way.

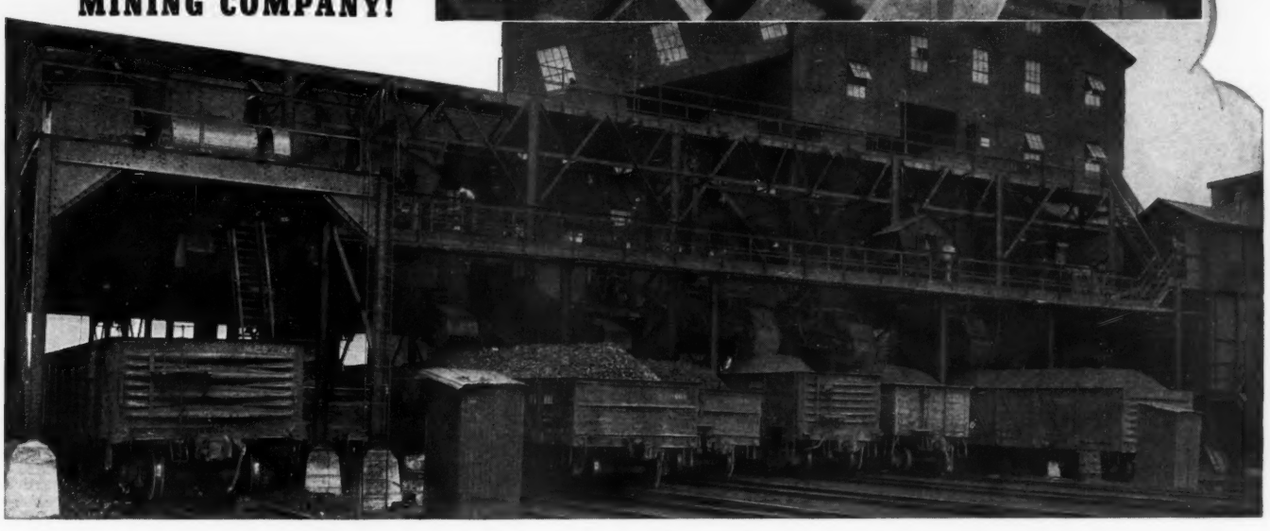
THE LOUIS ALLIS CO., MILWAUKEE, WIS.

LOUIS ALLIS

TYPE 400 SCREENS

assure continuous production of 5/16" x 10-mesh coal at BELL and ZOLLER COAL MINING COMPANY!





● Screening of 5/16" x 0" coal making a 10-mesh separation at the Zeigler Illinois plant of the Bell and Zoller Company is handled by five Type-400 Screens equipped with Tyler Screen cloth especially developed for such purposes!

These screens furnish a dependable, continuous flow of coal without maintenance worries and at extremely low screening cost.

The Type-400 is especially suited for screening damp coal even as fine as 28-mesh, the intense vibration produced by four powerful electric vibrators combined with a sharp impact thoroughly removes the undersize, "kicks" the openings clear of sticky near-mesh particles and clears the way for remarkably high tonnages.

Let us send you figures showing typical Type-400 Screen operations on difficult screening problems!

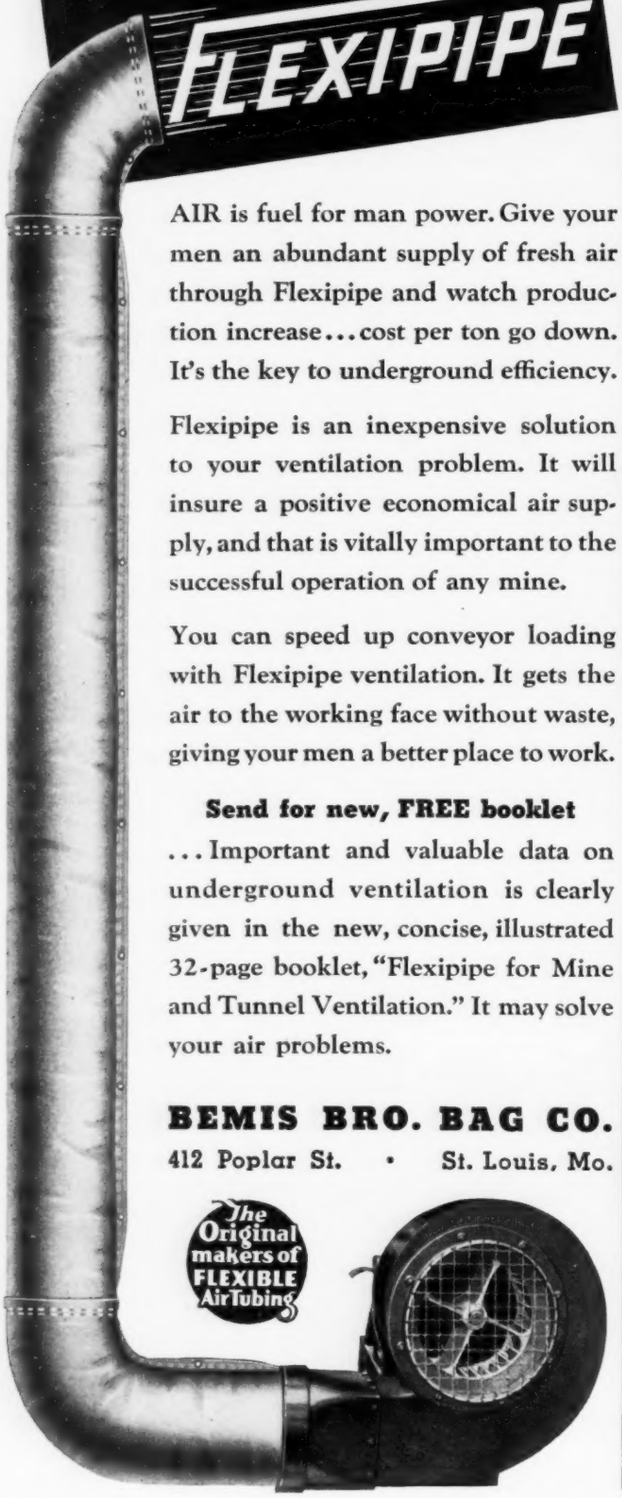
THE W. S. TYLER COMPANY, CLEVELAND, OHIO

MANUFACTURERS OF WOVEN WIRE SCREENS, SCREENING, DRYING, SCRUBBING AND TESTING SIEVE EQUIPMENT

TYLER SCREENS

TYPE-400—HUM-MER ELECTRIC SCREEN—TYLER-NIAGARA

GIVE YOUR MEN AIR THROUGH FLEXIPIPE



AIR is fuel for man power. Give your men an abundant supply of fresh air through Flexipipe and watch production increase... cost per ton go down. It's the key to underground efficiency.

Flexipipe is an inexpensive solution to your ventilation problem. It will insure a positive economical air supply, and that is vitally important to the successful operation of any mine.

You can speed up conveyor loading with Flexipipe ventilation. It gets the air to the working face without waste, giving your men a better place to work.

Send for new, FREE booklet

... Important and valuable data on underground ventilation is clearly given in the new, concise, illustrated 32-page booklet, "Flexipipe for Mine and Tunnel Ventilation." It may solve your air problems.

BEMIS BRO. BAG CO.

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The greatest help a coal mining man can have—

IF YOU want to make sure of getting your certificate of competency—sure of winning a bigger job with bigger pay, get Beard's great books today and put them to work for you.

In these three books you have a practical, always-on-the-job guide that will help you solve the problems you face every day, show you what to do, tell you why it should be done.

Beard's

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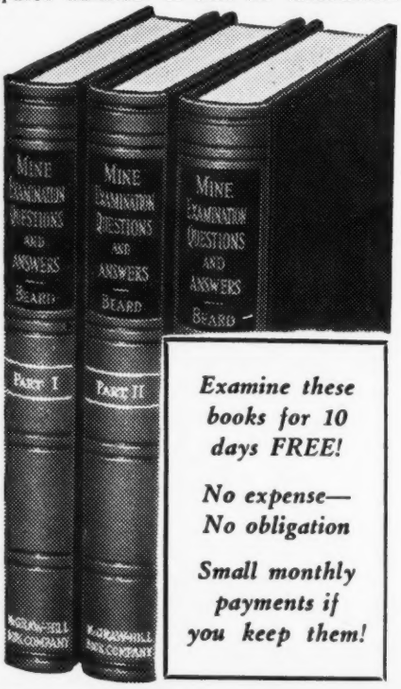
3 volumes—$7.50, payable in four monthly payments

THESE books explain what a man must know in order to become a mine inspector, a mine foreman, assistant foreman, fireboss, hoisting engineer, safety engineer, shot-firer, etc.

They give you complete and authoritative information about air and gases, explosives, safety requirements and methods, mechanics, engines, hoisting, drainage, pumping, ventilation, timbering, instruments, and every other detail that the practical mining man must know.

Thousands of men prepared for examination

These books have prepared hundreds of men for examination — prepared hundreds of men for bigger, better jobs.



For instance — C. E. Fountain writes: "Used *your books about three months; went before the State Board and made first Mine Foreman papers.*"

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Position C-12-37

(To insure prompt shipment write plainly and fill in all lines)

IT CUTS TIMBERING COSTS IN HALF

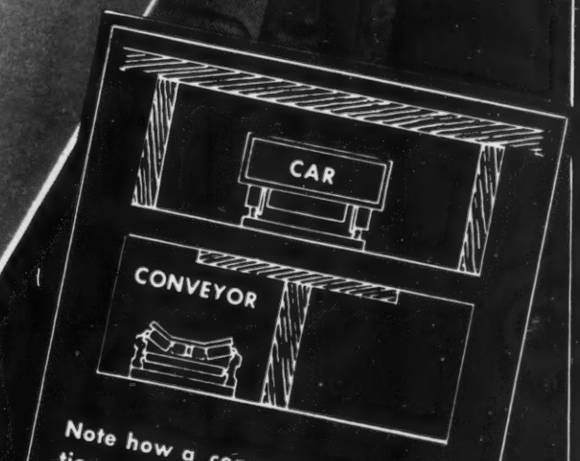
..INCREASES SAFETY and PRODUCTION

HOW much does timbering cost you per year in material and labor? How would you like to wipe at least 50% of that expense off your ledgers—*and be able to produce more coal with far lower accident-hazard?*

That is what you can do with a Goodyear Belt-equipped conveyor system. Belt conveyors, because of their continuous high-capacity operation, require far less space than any method of intermittent haulage. The belt runs close to the rib, making it possible to place single props directly under the center of the roof-load, doing away with side-timbers.

This type of timbering is not only 50% cheaper than conventional methods, but mine experience proves it is far safer because it provides solid perpendicular support at the point of greatest pressure. Yet this saving is only one of many effected by Goodyear belted conveyors which are enabling many progressive mines to market their product competitively with gas and oil.

Why not get the complete story from the G.T.M.—Goodyear Technical Man—a veteran of many years practical experience in mechanized mining. It costs you nothing to talk it over with this competent adviser. To bring him to your office, just write Goodyear, Akron, Ohio, or Los Angeles, California.



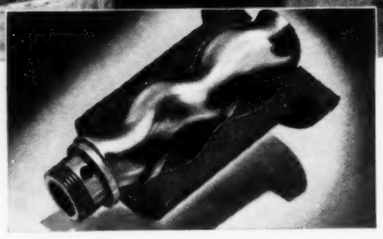
Note how a conveyor belt installation makes it possible to place maximum support directly under center of roof-load, using 50% less timber.

BELTS
MOLDED GOODS
HOSE
PACKING
Made by the makers of Goodyear Tires

THE GREATEST NAME IN RUBBER

GOODYEAR

MORE TONS ARE HAULED ON GOODYEAR CONVEYOR BELTS THAN ON ANY OTHER KIND



For

Dewatering Mines

...R & M MOYNO PUMPS

This extraordinary pump is offered as a distinct advance over any other known equipment for this purpose. After exhaustive tests in British collieries, it has been further perfected to serve the American coal-mining industry, by Robbins & Myers, Inc., sole licensees and makers.

The helical eccentric *rotor* pictured above (with cross-section of stator) is the distinctive feature of the Moyno pump. It operates as a piston in a cylinder of infinite length, continuously forcing the liquid ahead of the rolling action. An utterly new principle . . . the Moyno is neither a centrifugal, rotary, screw, nor reciprocating pump, yet it possesses many of the desirable characteristics of all these types.

The Moyno pump is non-clogging. It will handle solids in suspension, up to 30% or more—abrasive particles of coal, slate, or stone. It is valveless and requires no foot valve; is self-priming; is positive in displacement; has only one moving-part assembly; is simple and rugged in construction.

Powered by R & M Motors—accepted as America's quality motors for more than a third of a century.

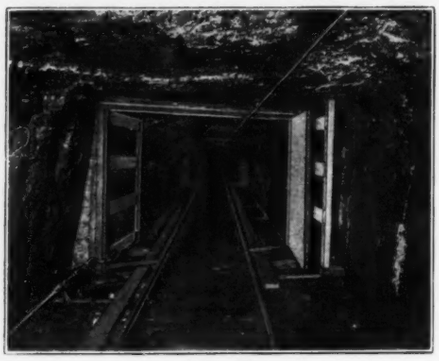
The Moyno pump is available in five capacities, ranging up to 175 gallons per minute. Let us tell you what it can do for *you*. . . . *Robbins & Myers, Inc., Pump Division, Springfield, O.*

ROBBINS & MYERS

Moyno Pumps

HOISTS • CRANES • MOTORS • FANS • FOUNDED 1878

AUTOMATIC DEVICES PAY THEIR WAY



TRAP THE AIR WITH AN AIR LOCK

THE OPEN DOOR TO PROFITS
EARNS ITS COST IN SIX MONTHS

OPENS IN A SPLIT SECOND
CLOSES ALMOST AS QUICKLY

A safety device that will make money for you. No attendant required. Can be bought outright, leased or paid for as trappers wages.

Combination installations of automatic door, switch thrower and signal system will eliminate all stops and speed your haulage safely.

Write for catalog and ask us to make a survey of your mine. No cost.

THE AMERICAN MINE DOOR CO.

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COMPLETE SERVICE for the Coal Industry

Everything for the efficient handling of coal is provided by Hendrick . . . . a dependable headquarters for your every need.

Perforated Plate	Elevator Buckets
Flanged Lip Screens	Chutes and Hoppers
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HENDRICK MANUFACTURING CO.

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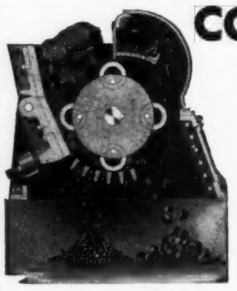
Sales Offices in Principal Cities.
Please Consult Telephone Directory.



COAL CRUSHERS

Stoker Coal or Other Small Sizes with Minimum of Fines . . .
RING and HAMMER CRUSHERS
• COAL PULVERIZERS •

The Williams Patent Crusher & Pulverizer Co.
2709 N. Broadway, St. Louis, Mo.
Sales Agencies Include
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Williams
PATENT CRUSHERS GRINDERS SHREDDERS

The Cincinnati

New One Man Coal Drill

This new extra powerful drill was designed and made to be used by a single workman for drilling shot-holes in both bituminous and anthracite coal.

It is *fully guaranteed* to have more power—"pound for pound" . . . and is sold on a "satisfaction or money back" basis.

WRITE TODAY for illustrated literature describing "The Cincinnati" Electric Tools and their good work in the Coal Mining Field. Learn how they can help *you* cut costs!

The Cincinnati Electrical Tool Co.

(Division of The R. K. LeBlond Machine Tool Co.)

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- They increase your trolley wire life—
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- They surpass other trolley wheels in quality, design and performance—
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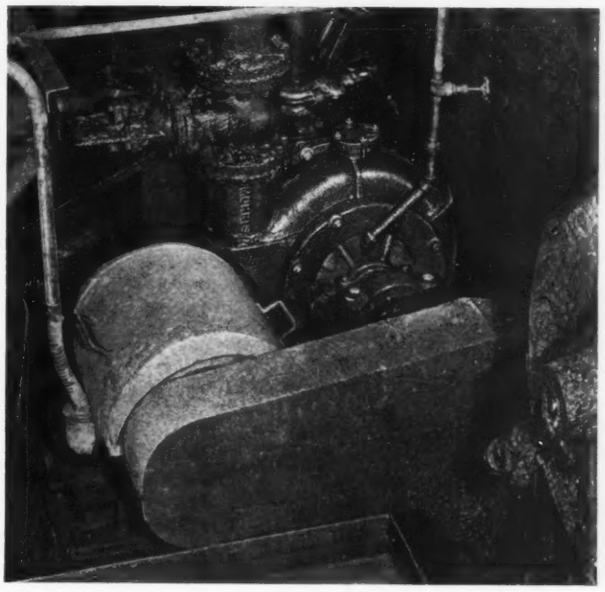
Send for our new catalog S-C.

The Star Brass Works

KALAMAZOO, MICHIGAN

The MORRIS HYDRAULIC COLUMN

News of interest to Centrifugal Pump Users



The largest soft coal cleaning system in the country uses Morris Pumps . . . . .

PUMPS on coal cleaning systems have a tough assignment. It isn't safe to predict what will be carried in the water to be handled—the only certainty is that these pumps will be subjected to severe abrasive and corrosive action.

The engineers of the Chance Coal Cleaning Process first tried out Morris Centrifugal Pumps many years ago. Each successive installation proved that Morris Pumps were fully equal to their task. Long-wearing materials, sturdy construction, efficient design, and trouble-free service has been the invariable report each time Morris Pumps have been used in these systems.

Naturally, therefore, Morris Pumps have been included in the latest Chance installation—the 1000-ton per hour system at the Bell & Zoller Mines, the largest soft coal cleaning system in the country.

On all other anthracite and bituminous coal mine services, too, Morris Pumps have frequently and fully demonstrated their thorough-going reliability. Whatever may be your pumping requirements — whether coal cleaning, mine drainage, unwatering, boiler feed, fire protection or general service, be sure to investigate Morris designs and get a Morris quotation.

Bulletins on request

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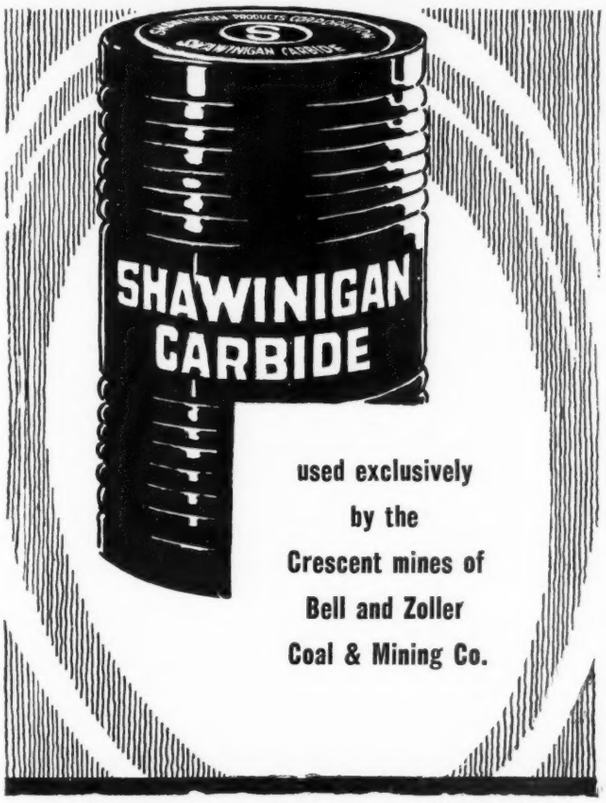
cut haulage costs for BELL & ZOLLER

THE haulage modernization program at Zeigler Nos. 1 and 2 Mines has included rapid adoption of STERLING Cast Steel Mine Car Wheels. At Zeigler No. 1 the new all-steel 4.3 Tons capacity mine cars, of which there are now 150 in use, are all equipped with STERLING Wheels. The older type wooden cars are also being equipped with these Cast Steel Wheels.

STERLING STEEL CASTING CO.
East St. Louis Illinois
For Sterling Wear use Sterling Cast Steel Mine Car Wheels



used exclusively by the Crescent mines of Bell and Zoller Coal & Mining Co.

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LIGHT WEIGHT TOOLS

RELIABLE - DEPENDABLE - ECONOMICAL

Today High-Speed Haulage makes it necessary to have smooth, evenly curved and properly joined trackage. UMECO Tools not only accomplish this, but are easily handled and carried swiftly from place to place by one man, and also, safety is promoted when good track construction is made faster and easier.

UMECO LIGHT WEIGHT TOOLS ARE IN USE AT BELL & ZOLLER'S MECHANIZED ZEIGLER'S NO. 1, NO. 2 AND CENTRALIA MINES. UMECO Light Weight Tools are needed by your track layers. Write today for full particulars.

UTILITY MINE EQUIPMENT CO.
620-30 Tower Grove Ave. St. Louis, Mo.

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Know What Is Underground

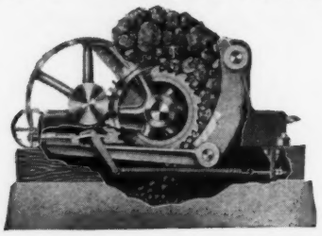
by

DIAMOND CORE DRILL EXPLORATION

WE SPECIALIZE IN TESTING BITUMINOUS COAL LANDS
Many of the most prominent and successful coal operators and mining engineers throughout the country are our patrons. We have more than forty steam, electric and gasoline drills, adapted for any core drilling job in any field. Satisfactory cores guaranteed. Our prices are right.

HOFFMAN BROS. DRILLING CO.
PUNXSUTAWNEY, PA.
Established 1902 ..... Telephone 382

COAL CRUSHERS



We build a type and size for every coal crushing requirement. 100 years of experience is your assurance that we know how. Quotations on request.

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Established 1835 HOLIDAYSBURG, PENNA.

1¾" diameter.—2½" x 14" inside

Avoid Wrecks

Lighter, stronger, safer to couple than the old type punched link.
Send for blue print.

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readers scan these pages for news of what your product can do for them.

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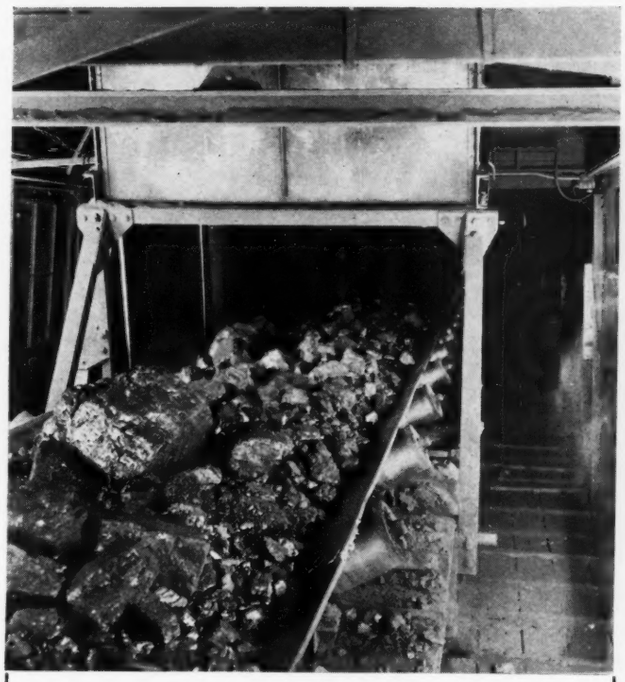

"WEIGHING WHILE CONVEYING"

without weighman — *at* Bell & Zoller

In the modern 1000 ton an hour coal cleaning plant of Bell & Zoller Coal Mining Company, at Zeigler, Illinois, Merrick Weightometer accurately checks tonnage fed into the plant from the No. 2 Mine.

This modern method of keeping a constant check on production is typical of the practice followed in the many plants where Merrick Weightometers are in use. By accurately and economically weighing, registering and recording the tonnage handled by belt conveyors every hour of the day, Merricks assure substantial savings in production control and in material handling.

Ask Merrick engineers to show you how you, too, can profit from the use of Weightometers and how easily they can be applied to any size or style belt conveyor, inclined or horizontal.

MERRICK SCALE MFG. CO.

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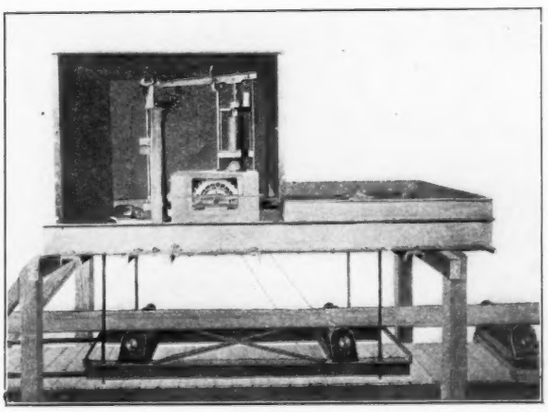
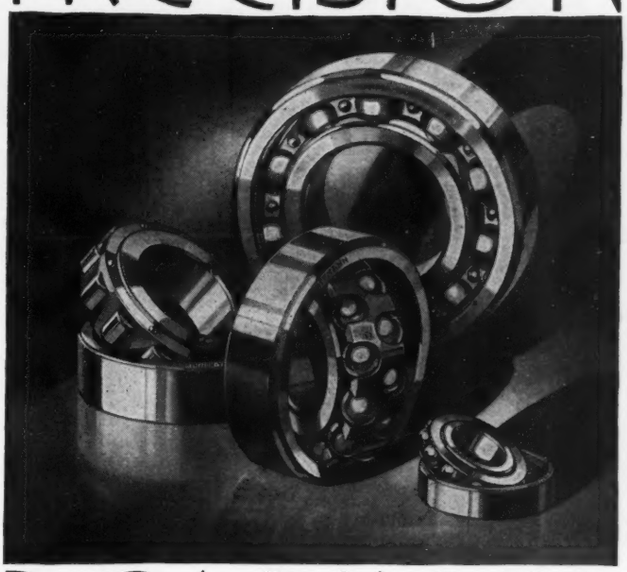


Weightometer on Belt Conveyor with Front Sheet of Casing Removed

PRECISION



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PRECISION — as the term defining the characteristics distinctive of NORMA-HOFFMANN Bearings — comprehends ALL those qualities which reveal themselves in higher anti-friction efficiency, greater speed-ability, better performance, longer life, fewer replacements, improved production. ✲ ✲ ✲ These are the definite and tangible gains which accrue to the builder and user of any machine in which NORMA-HOFFMANN PRECISION Bearings are incorporated. ✲ ✲ ✲ Write for the PRECISION Bearing Catalogs. ✲ ✲ ✲ Let our engineers work with you — without obligation.

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PRECISION BEARINGS

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NORMA-HOFFMANN BEARINGS CORP., STAMFORD, CONN., U. S. A.

WOOD PIPE for Mine Drainage

Wyckoff Wood Pipe has an 82-year record of perfect resistance to the corrosive action of sulphurous mine water. It is an ideal, long-time investment—light, easy to lay, and relatively low in first cost.

We also manufacture a special Hard Maple Pipe for flushing culm and wood covering for underground steam lines.

shipments from stock day after receipt of order. Send for catalog.

Established 1855

Emergency orders can be delivered by Truck to Mines in Pennsylvania Coal Fields following morning after receipt of same.

A. WYCKOFF & SON CO.
Office and Factory, Elmira, N. Y.
The Originators of Machine Made Wood Pipe

MINE NO. 2, BELL & ZOLLER

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SELF-DUMPING
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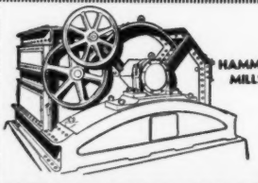
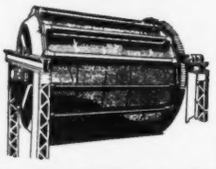
HOLD THE WORLD'S RECORD FOR TONNAGE HOISTED

Write for descriptive bulletin.

EAGLE IRON WORKS
DES MOINES, IOWA





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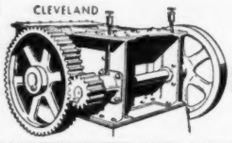

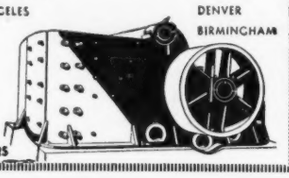

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Manufactured exactly to your specifications
Any size or style screen, in thickness of steel wanted with any size perforation desired.
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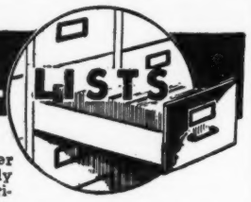

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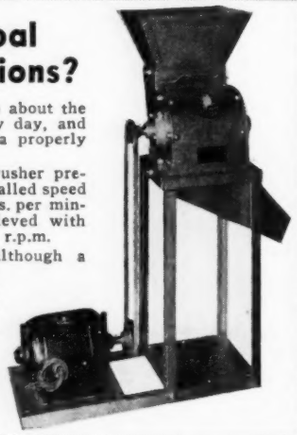
There's only one way to be sure about the quality of your product, day by day, and that is by constant testing in a properly equipped laboratory.

The WISE Laboratory Coal Crusher prepares coal for testing with unequalled speed and economy. Capacity of 25 lbs. per minute through 3/8" screen is achieved with 3/4 hp. motor operating at 2500 r.p.m.

WISE Laboratory Crushers, although a comparatively new product, are already used and endorsed by some of the most prominent coal testing organizations in the United States. Write today for complete information.



O. B. Wise Pulverizer Co.
Knoxville, Tenn.

HARDSOCG CUTTER HEADS

SPEED DRILLING
for Bell & Zoller

As you would expect in a modern mechanized mine, where low tonnage costs are the objective—Bell & Zoller use HARDSOCG CUTTER HEADS, BITS and AUGERS to speed up drilling operations.

The cutter head shown is but one of many different types and sizes available.

HARDSOCG Also Manufactures:

Vertical and horizontal electric and gasoline driven drilling machines and conveyor augers for coal stripping operations. Strip Pit sweeping machines. Ball Bearing differentials, Caterpillar jack shafts and gathering arm points for loading machines.

HARDSOCG
MANUFACTURING CO.
OTTUMWA, IOWA

E-8 — One of many styles — oxfords and high shoes

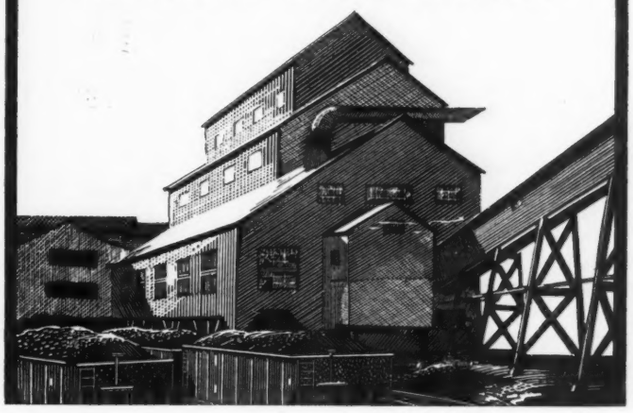
THE FAMOUS SAFETOE SHOE!

Recommend SAFETOE Shoes first of all because they are safe—because their tested steel toe-caps give your men protection where protection is needed most. Recommend SAFETOE Shoes because the good quality, flexible leather is easy on their feet—gives extra wear, extra protection. Recommend SAFETOE Shoes because they combine the big safety features with good styling—because they can be worn *anywhere*—because they give your men more for their money.

BROWN SHOE COMPANY • CENTRAL SHOE COMPANY
Manufacturers and Distributors, St. Louis

TREAT AT THE *Tipple*

FOR SAFETY • • YEAR ROUND USEFULNESS • • • AND EFFECTIVE DUSTPROOFING



FOR SAFETY Fire, explosion and combustion hazards at the tipple are increased or decreased by the form of dust treatment used. Some methods increase the dangerous volatile elements that are responsible for so many fires in tipples. Calcium Chloride solution, although ignition-proof in itself, improves the normal burning qualities of the coal in the furnace. Calcium Chloride also minimizes dust explosion hazards by holding dust firmly bound with moisture. Calcium Chloride will help cut down fire hazards as well as dustproofing costs.

YEAR ROUND USEFULNESS Calcium Chloride solution flows freely in cold weather, making its application practicable in winter as well as in summer. This treatment makes possible unfrozen deliveries of dustless coal in coldest weather.

EFFECTIVE DUSTPROOFING THAT LASTS It matters little to the householder that coal be dustless in the car or storage pile. Any dustproofing treatment that fails to last until the coal is burned is not satisfactory to the ultimate consumer, and he is the fellow who decides what kind of fuel will be burned. Foresighted stoker manufacturers now realize that their sales problems are identical with those of the coal mine operator and that Calcium Chloride dustproofing is their best sales aid.

For the good of your business, deliver safe, odorless, dustless coal, treated with Calcium Chloride.

CALCIUM CHLORIDE ASSOCIATION
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Michigan Alkali Co. 60 E. 42nd St., New York City
Solvay Sales Corp. 40 Rector St., New York City
The Columbia Alkali Corp. - Barberton, Ohio

CALCIUM CHLORIDE
KEEPS COAL DUSTLESS

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(See ¶ on Box Numbers)
Proposals, 40 cents a line an insertion.

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4 to 7 inches..... 5.50 an inch
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POSITIONS WANTED

WANTED: Position with coal mining company, either in engineering or production department, good map draftsman, references. PW-451, Coal Age, 520 No. Michigan Ave., Chicago, Ill.

WANTED

GOODMAN LOW VEIN Shortwall Mining Machine Type 212AA 550 Volts DC, 36" track guage. Give price and shipping point with description. W-461, Coal Age, 330 West 42nd Street, New York City.

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FOR SALE

Locomotives — Mining Machines
Pumps—Motors — Transformers
Steel Tipples — Rescreeners
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Engines — Generators — Scales
Miscellaneous Mine Equipment.

My own modern machine shop is available to repair and modernize your equipment.

Complete Mines dismantled and sold.

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Mine Equipment and Supplies
Office and Warehouse
209-211 West Reed Street,
BENTON, ILLINOIS

M.G. SETS & ROTARY CONVERTERS
300 KW. G.E. 250 v. DC 2300/3/60 .35% leading P.F. Syn. motor with swbd.
300 KW. Westgh Pedestal Rotary 250 v. 6 phase with transformers and swbd.
150 KW. G.E. 275 v. 2200/3/60
150 KW. Westgh 275 v. 2200/3/60
150 KW. Westgh Rotary 275 v. 1200 rpm.
100 KW. Westgh 275 v. 2200/3/60
SLIP RING MOTORS
4—700 HP. G.E. 2200/3/60/393 rpm. Contac. Cont.
4—500 HP. G.E. 2200/3/60/450 rpm. Contac. Cont.
LOCOMOTIVES & MINING MACHINES
13 Ton Bald. Westgh. 250 v. 42" ga. 908 motors
10 Ton G.E. 250 v. 42" ga. B.B. motors
10 Ton Milwaukee Gasoline locomotive 40/42" ga.
6 Ton Same as the above
5 Ton Jeffrey 250 v. 36/42" ga. MH89 motors
6—5 Ton G.E.-Westgh.-Atlas Battery Locos 40/44"
10—CE7 Sullivan Shortwall 250 v. DC.
112 DA Goodman univer. 250 v. 6' cutter bar
112 G3 Goodman A.C. universal 6' bar
2—24"x24" Double roll coal crusher.
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1—50 HP Lidgerwood Single Drum
1—50 HP Lidgerwood Double Drum
1—150 HP Ottumwa Tail Rope or Single
2—400 HP Vulcan Cyl.-Conical Shaft
1—600 HP Nordberg Cyl.-Conical Shaft
1—800 HP Hardie-Tynes 6000' Slope

SUB-STATIONS
1—500 KW Westgh. Rotary 250/2300
2—200 KW Westgh. Mg. Sets 250/2300
3—200 KW Geco Mg. Sets 500/2300

CRUSHERS
1—18x18 Jeffrey Single Roll Coal
1—24x20 Jeffrey Double Roll Coke

LOCOMOTIVES
1—10 Ton Jeffrey O.S. Frame 42" Ga.
1—5 ton Westgh O.S. Frame 42" Ga.

CONVEYORS
1—240' Centers 30" and Others

JOHN D. CRAWBUCK CO.
Engineers—Appraisers
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1—200 KW GENERAL ELECTRIC SYNCH. M.G. SET, ATI Motor, 1200 RPM, .8 P.F., 2300/4000 V., MPC Gener., 500 V., Manual Control.
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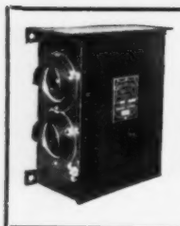

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